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ELECTRONIC DESIGN

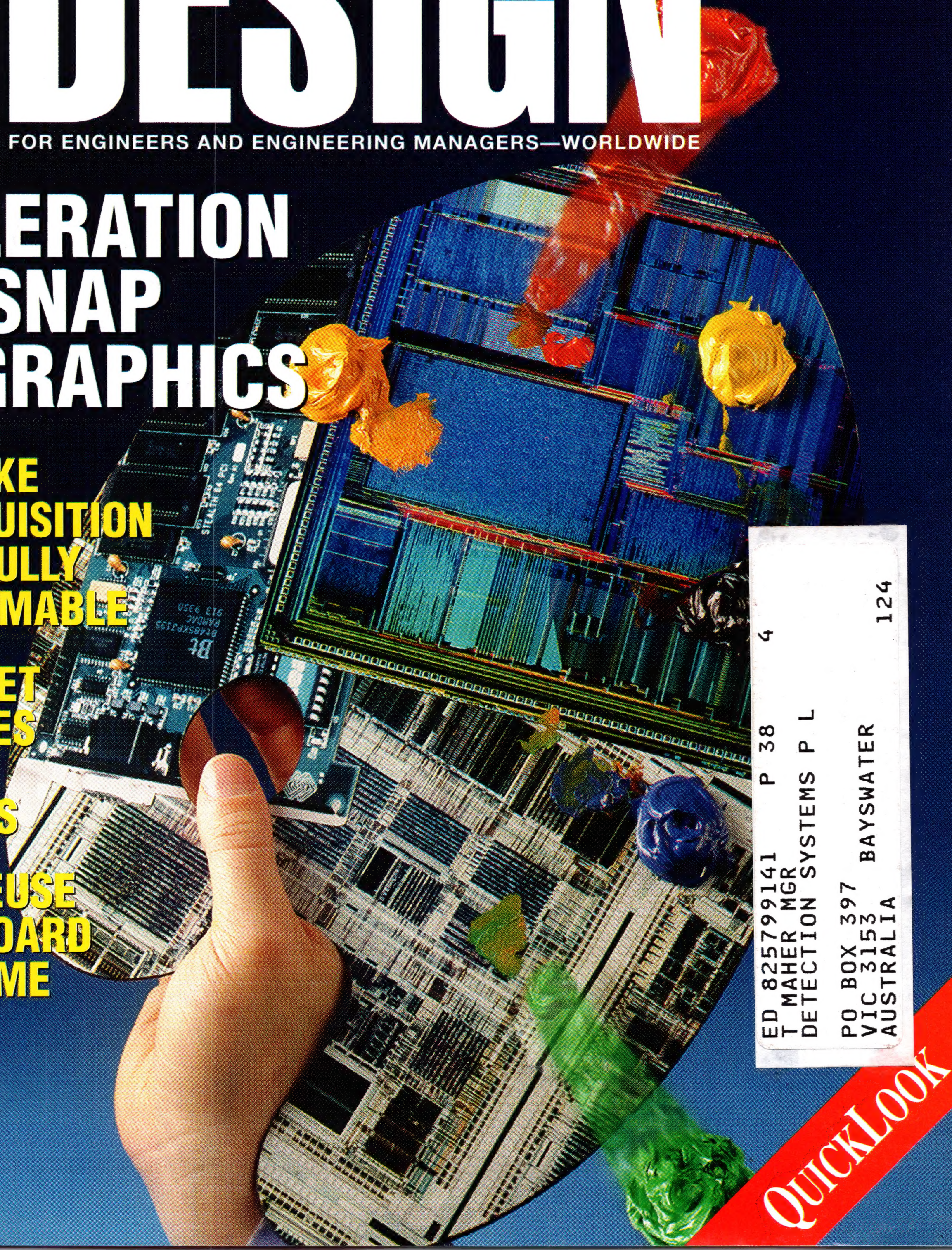
JULY 25, 1994

18 OCT 1994

FOR ENGINEERS AND ENGINEERING MANAGERS—WORLDWIDE

ACCELERATION PUTS SNAP INTO GRAPHICS

- ASICS MAKE DATA ACQUISITION BOARDS FULLY PROGRAMMABLE
- PC CHIP SET INTEGRATES ALL LAN FUNCTIONS
- DESIGN REUSE SPEEDS BOARD DESIGN TIME
- PEASE PORRIDGE



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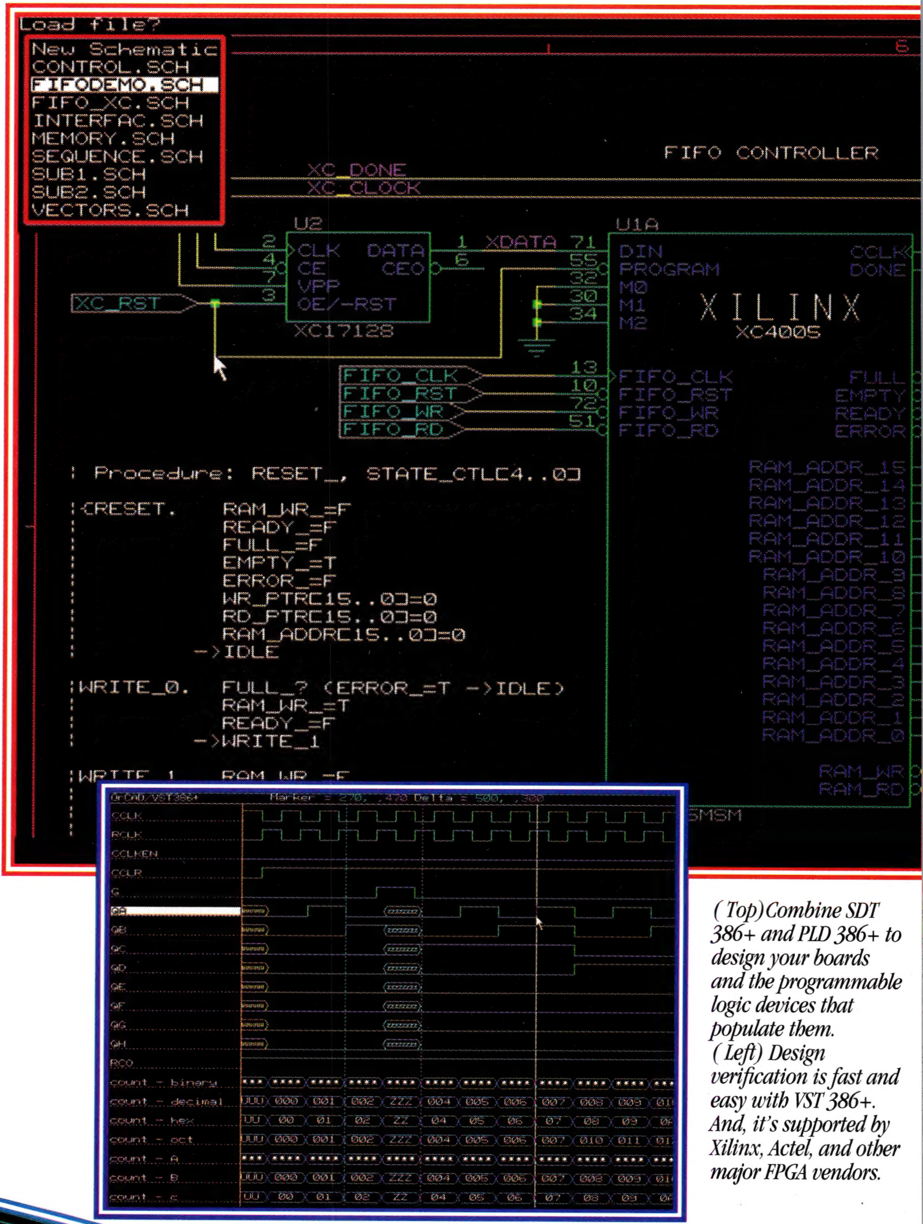

```
; Procedure: RESET_, STATE_CTL[4..0]

;{RESET.    RAM_WR_=F
;           READY_=F
;           FULL_=F
;           EMPTY_=T
;           ERROR_=F
;           WR_PTR[15..0]=0
;           RD_PTR[15..0]=0
;           RAM_ADDR[15..0]=0
;        ->IDLE

;WRITE_0.   FULL_? {ERROR_=T ->IDLE}
;           RAM_WR_=T
;           READY_=F
;        ->WRITE_1

;WRITE_1    RAM_WR_=F
```

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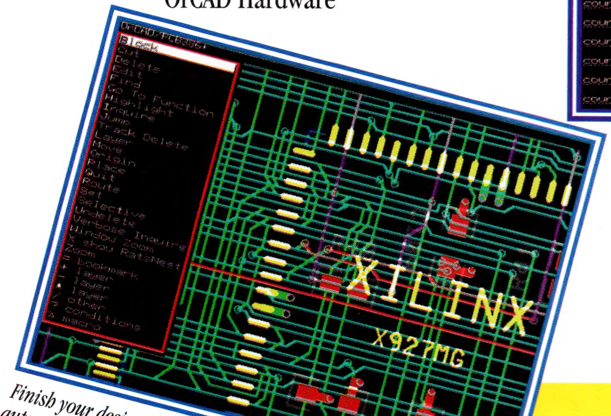

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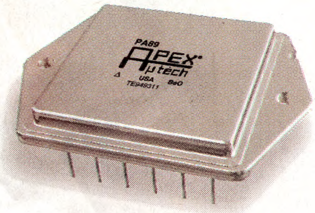
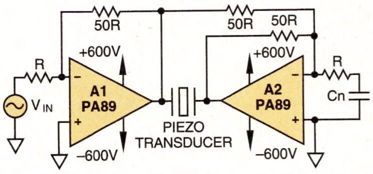


Highest Voltage Supply

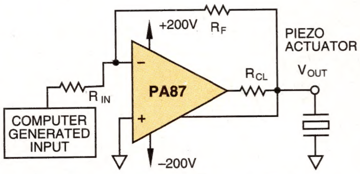
If you're working with supplies of ±75V to ±600V, take a look at the industry's highest voltage power amp—the **PA89**. Output voltages can swing up to 1140V peak to peak with output current up to 75mA.



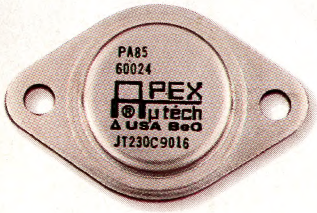
±1100V Single Axis Micro-Positioning

High Output Current

The **PA87** combines a wide supply range of 100V to 450V with its high output capabilities. You'll also be impressed by its low 3mA of quiescent current. Housed in a 10-pin SIP, it's also a low cost solution priced **$52.00** in 10K.

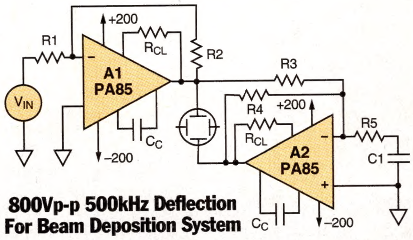


Deformable/Segmented Mirror Actuator

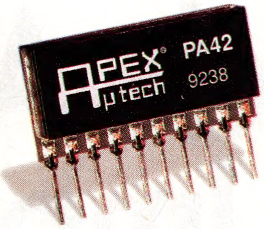


High Speed

If it's speed you need, the **PA85** offers a wide supply range of ±15V to ±225V with a typical slew rate of 1000V/μs. The **PA85** achieves this exceptional speed at a power bandwidth of 500kHz and ±200mA of output current. It's also available in a hi-rel military grade.

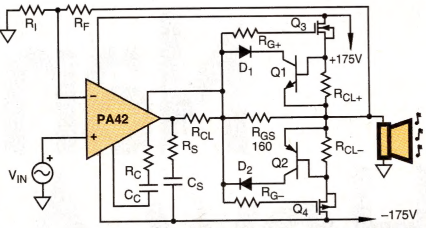


800Vp-p 500kHz Deflection For Beam Deposition System

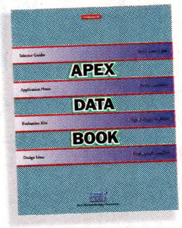


Low Cost Monolithic

The **PA42** is the industry's only monolithic power amp capable of operating on a supply range of 100V to 350V. At **$13.60** in 10K pieces, it's also the industry's lowest cost high voltage power amp. The **PA42** is rated at 120mA of output current and a mere 2mA of quiescent current. Also available in die form.



PA42 With External MOSFETS Creates A Super Power Audio Amp Subwoofer Driver



Free Data Book and Application Notes

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PA87	100V-450V	300mA	3mA	7.5W	$52.00
PA85	30V-450V	350mA	25mA	40W	$82.05
PA42	100V-350V	120mA	2mA	9W	$13.60
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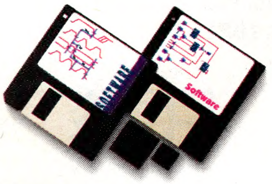

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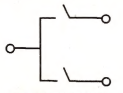

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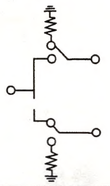
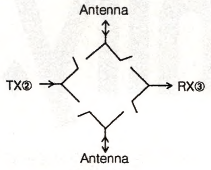


SPDT ABSORPTIVE



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JULY 25, 1994 VOL. 42, NO. 15

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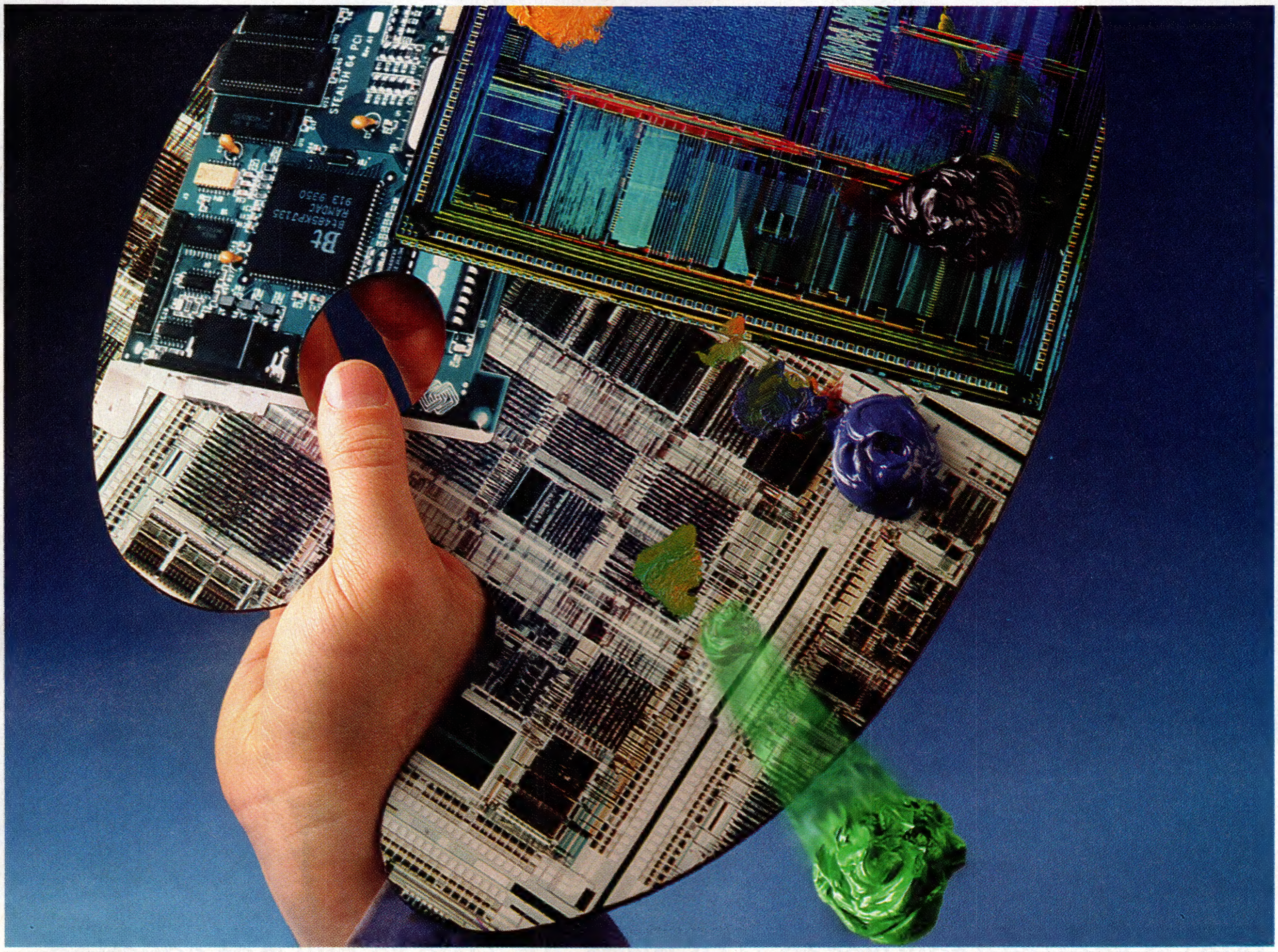

COVER FEATURE/ SPECIAL REPORT ACCELERATION PUTS THE "SNAP" INTO GRAPHICS . . . 55
Dedicated graphics support chips accelerate operations to improve drawing speeds.

DESIGN APPLICATIONS DESIGN REUSE ACCELERATES BOARD CREATION . . . 77
By structuring board designs into functional blocks, those blocks can be reused in subsequent boards, thus reducing design time.

PRODUCT INNOVATIONS PC CHIP SET INTEGRATES LAN FUNCTIONALITY . . . 141
NE2000 Ethernet LAN controller combines with I/O capabilities in a single chip for PC platforms.

DATA BOARDS BECOME SWITCHLESS, JUMPERLESS . . . 143
A pair of custom ASICs make the E-series data-acquisition boards completely software configurable and boost performance, too.

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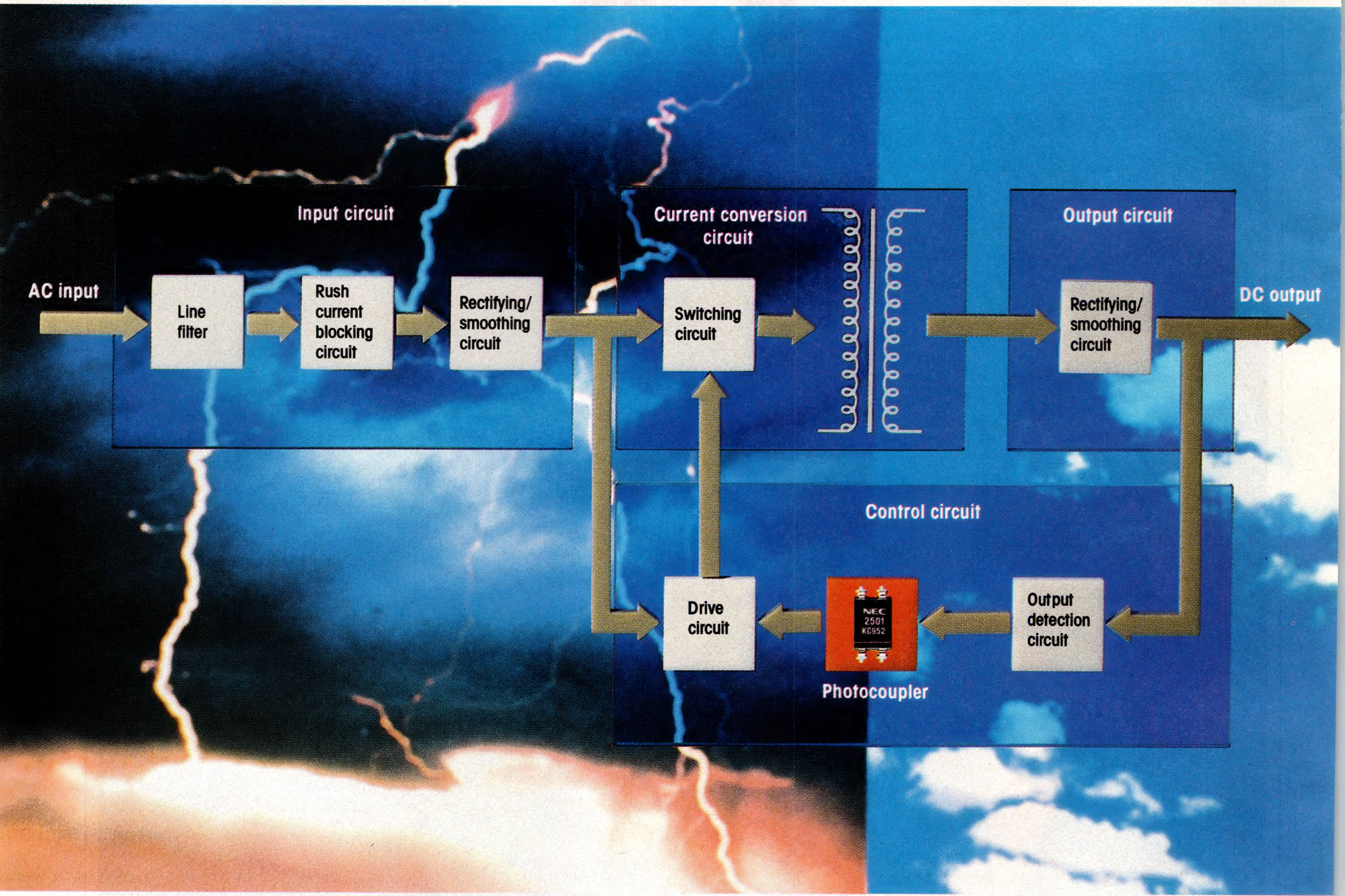
Phenomenal Photocouplers.



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ELECTRONIC DESIGN

40 YEARS AGO IN ELECTRONIC DESIGN . . . 8
Accurate voltmeter; transistor data chart

MEETINGS . . . 11

EDITORIAL . . . 16
Cooperation

TECHNOLOGY BRIEFING . . . 20
Fast FETs/IGBTs need fast rectifiers

TECHNOLOGY NEWSLETTER . . . 27
- ARPA program pushes auto accelerometers
- OS source code released for PowerPC
- Software supports PCMCIA flash files
- IEEE P996.1 standard nears completion
- ASIC to speed up STD 32-bus designs
- The push is on to develop ferroelectrics
- Sensor helps store 20X more disk data
- Sensor converts light to digital format

TECHNOLOGY ADVANCES . . . 35
- Low-cost wideband spread-spectrum device promises to revolutionize radar proximity sensors
- Color-recovery scheme lets 8-bit graphics systems deliver close to 24-bit quality
- Fast silicon challenges exotic technologies for the Infobahn
- Advanced technologies and circuits spotlight the Hot Interconnects and Chips Symposiums

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1975 Two Certificates of Merit
1976 Certificate of Merit
1978 Certificate of Merit
1980 Certificate of Merit
1986 First Place Award
1989 Certificate of Merit
1992 Certificate of Merit

IDEAS FOR DESIGN . . . 91
- Stretch ADC dynamic range
- Very-low-noise 5-V regulator
- Vary rep rate, duty cycle with a 555
- Crystal-accurate sinewave generator

QUICK LOOK . . . 99
- Kmet's Korner
- Tales from a Skunk Works
- My View: Generational Wars
- Offers you can't refuse

PEASE PORRIDGE . . . 105
Bob's Mailbox

PIPS SPECIAL EDITORIAL SECTION

Designing a notebook power supply . . . 109
Power-source manufacturers lists . . . 120
Products . . . 132

PRODUCT NEWSLETTER . . . 146
- 66-MHz system holds 11.8-in. color LCD
- SCSI-2 host adapters increase performance
- Super-VGA comes to portable systems
- Flash vendors to ensure pins-out compatibility
- SCSI terminator packs logic-based disconnect

NEW PRODUCTS

Analog . . . 148
Computer Boards . . . 150
CAE . . . 152
Digital ICs . . . 154
Instruments . . . 157

INDEX OF ADVERTISERS . . . 160

READER SERVICE CARD . . . 161A-D

COMING NEXT ISSUE

- Probing the Intelligent Network: Is the network going to be the computer?
- Pros and cons of using simulation backplanes to integrate EDA tools
- First details on GaAs power rectifiers for high-frequency switching
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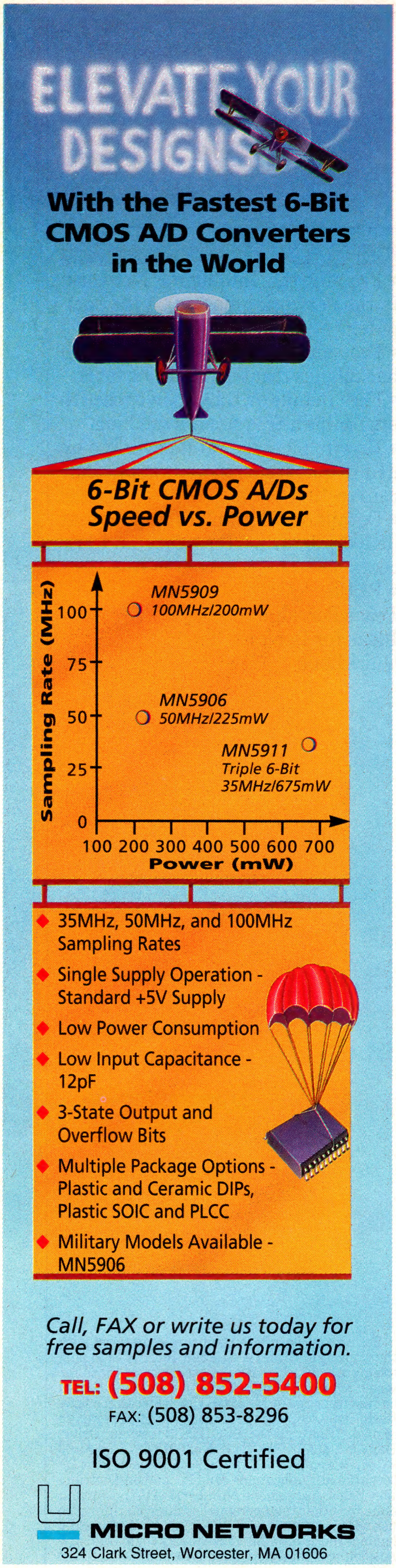

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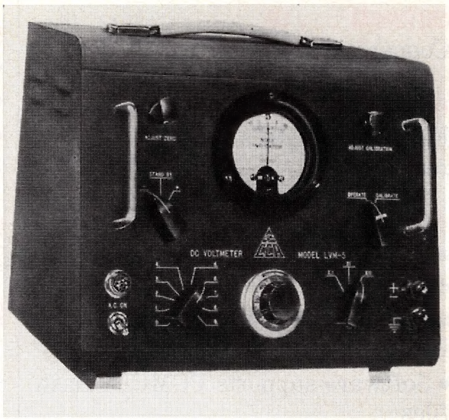
Extremely low d-c voltages can be measured with speed, accuracy, and minimum loading with the Model LVM laboratory standard voltmeter. The instrument can be used to calibrate meters, transducers, strain gages and thermocouples. As a nullmeter, its sensitivity is greater than 5µV. It may be used as a comparison bridge to measure resistive differences to an accuracy of 0.01%. As a current meter, accurate readings are possible in the millimicroampere range.

The unit is a nulling voltmeter consisting essentially of a highly stabilized power supply, an accurately calibrated attenuator, a high-gain chopper amplifier and a sensitive null indicator. In operation, the voltage to be measured is applied to one of the chopper contacts. The attenuator, which is across the regulated supply, has its output applied to the other chopper contact. The 60cy square wave that then appears on the chopper arm is amplified and fed to a phase sensitive detector. The resultant d-c voltage viewed on the zero-center null indicator causes a deflection to the right for too high an attenuator setting. When the indicator is zeroed, the two voltages on the chopper contacts are equal, and the value of the unknown may be read directly from the setting of the attenuator.



The range of the unit is 0-100v d-c, positive or negative grounded. The effective scale length is 114 ft. Linearity is better than 0.05% on any one range, and 0.1% overall. The input current is less than 10^{-11} amp. Absolute accuracy is 0.1% of the reading. Two versions of the instrument are available. Model LVM-5 is a portable unit 10-7/8" wide x 9-5/16" high x 11" deep, while Model LVM-5R is designed for rack mounting. The instruments are manufactured by the Computer Company of America, Division of Bruno-New York Industries Corp., 149 Church St., New York 7, N.Y.*(Electronic Design, July 1954, p. 32.)*

Instruments of this specialized type often had a handcrafted look, evidently with little attention paid to the aesthetics of external appearance. However, many of them were excellent instruments that could hold their own against their counterparts of today.—SS

Transistor data chart

Commercially available transistors are listed on the chart shown on these pages. This is the second such compilation (see Electronic Design, July, 1953, p. 11). Transistors being produced for military consumption only or those made for special users are not included. The following companies are listed as sources of transistors: Amperex Electronic Corp.; CBS-Hytron, Division of Columbia Broadcasting System; General Electric; Germanium Products Corp.; Hydro-Aire, Inc.; Minneapolis-Honeywell Regulator Corp.; National Union Radio Corp.; Philco Corp.; Radio Corporation of America; Radio Receptor Co.; Raytheon Manufacturing Co.; Sylvania Electric Products; Texas Instruments; Transistor Products, Inc.; Transitron Electronic Corp.; Tung-Sol Electric; and Westinghouse Electric Corp.*(Electronic Design, July 1954, p. 12.)*

Space constraints prevent us from publishing the complete two-page chart. It listed about 140 transistors, with maximum ratings, typical operating characteristics, and typical applications. Reflecting the industry at that time, the manufacturers' list has a strong East-coast flavor: 14 of the 17 companies were located in New Jersey, Pennsylvania, New York, or Massachusetts. A year later, Bill Shockley moved to Mountain View, Calif., hired luminaries like Bob Noyce, Gordon Moore, and Jean Hoerni, and Silicon Valley was off and running.—SS

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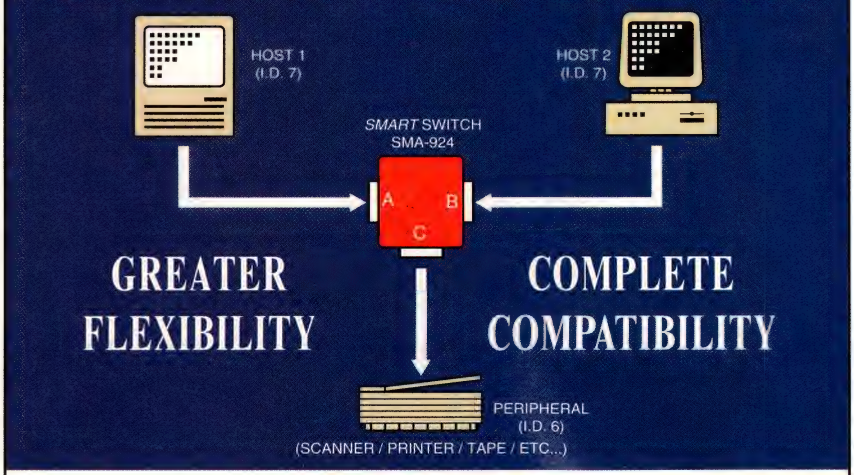

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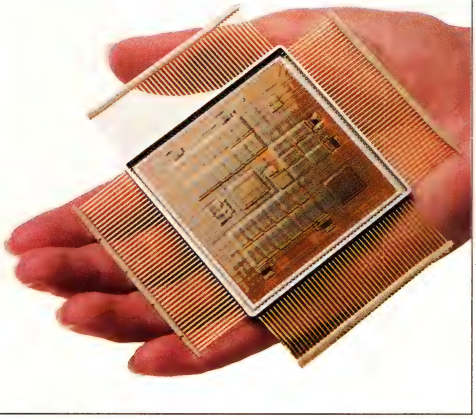

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UPCOMING MEETINGS

AUGUST

MACWORLD Expo/Boston, Aug. 2-5. Bayside Expo & World Trade Center, Boston, MA. Contact Mitch Hall & Associates at (617) 361-2001.

3rd IEEE International Symposium on High Performance Distributed Computing, Aug. 3-5. Westin St. Francis Hotel, San Francisco, CA. Contact Geoffrey C. Fox, NPAC Director, Room 3-228, 111 College Pl., Syracuse, NY 13244-4100; (315)443-4741; fax (315) 443-1973; E-mail: Gcf@pac.syr.edu.

4th IEEE Workshop on Computers in Power Electronics, Aug. 7-10. The Universite du Quebec, Trois-Rivieres, Quebec, Canada. Contact Adam Skorek, Dept. d'Ingenierie, UQTR, C.P. 500, Trois-Rivieres, Quebec G9A 5H7, Canada; (818) 376-5071 ext. 3929; fax (819) 376-5152.

IEEE International Symposium on Applications of Ferroelectrics, Aug. 7-10. Conference Center, University Park, PA. Contact Amar Bhalla, 253 MRL, Pennsylvania State University, University Park, PA 16802; (814) 865-9232.

IEEE International Geoscience & Remote Sensing Symposium (IGARSS '94), Aug. 8-12. California Institute of Technology, Pasadena, CA. Contact Tammy I. Stein, IEEE/GRSS, 2610 Lakeway Dr., Seabrock, TX 77586; (713) 291-9222; fax (713) 291-9224.

IEEE Magnetic Recording Conference (TMRC '94), Aug. 16-20. University of California, La Jolla, CA. Contact Roger F. Hoyt, IBM Almaden Research Center, 650 Harry Rd., K01/803, San Jose, CA 95120-6099; (408) 927-2118; fax (408) 927-3204.

IEEE International Symposium on Electromagnetic Compatibility, Aug. 22-26. Palmer House Hotel, Chicago, IL. Contact H.R. Hofmann, 1210 Lawn Meadow Ln., Naperville, IL 60540; (708) 979-3627; fax (708) 979-5755.

Conference on Lasers & Electro-Optics, Europe & The 5th European Quantum Electronics Convention (CLEO EUROPE/EQEC), Aug. 28-Sept. 2. RAI Congress Centre, Amsterdam, The Netherlands. Contact Susan Evans, IEEE/LEOS, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331; (908) 562-3896; fax (908) 562-1571.

SEPTEMBER

IEEE International Symposium on Compound Semiconductors, Sept. 18-22. Del Coronado Hotel, San Diego, CA. Contact James Harbison, Bellcore, 331 Newman Springs Rd., Room 3X-211, Red Bank, NJ 07701; (908) 758-3386; fax (908) 758-4372.

14th IEEE International Semiconductor Laser Conference, Sept. 19-23. Hyatt Regency Maui, Maui, HI. Contact Samantha H. Phillips, IEEE/LEOS, 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08855-1331; (908) 562-3894; fax (908) 562-1571; E-mail: s.phillips@ieee.org.

ASIC Conference and Exhibit (ASIC '94), Sept. 19-23. Rochester Riverside Convention Center, Rochester, NY. Contact Paul P.K. Lee, Eastman-Kodak Co., Rochester, NY 14650-2008; (716) 477-2869; fax (716) 477-4947.

AUTOTESTCON '94, Sept. 20-22. Disneyland Hotel, Anaheim, CA. Contact Robert Rassa, ManTech International, 150 S. Los Robles Ave., Suite 350, Pasadena, CA 91101; (818) 577-7100; fax (818) 577-7102.

Canadian Conference on Electrical and Computer Engineering, Sept. 25-28. World Trade & Convention Centre, Halifax, Nova Scotia, Canada. Contact C. Robert Baird, Dept. of Electrical Engineering, Technical University of Nova Scotia, P.O. Box 1000, Halifax, Nova Scotia, B3J 2X4, Canada; (902) 420-7717; fax (902) 422-7535.

Information Superhighway Summit/San Jose, a ComNet Conference, Sept. 26-28. Red Lion Hotel, San Jose, CA. Contact Jeff Silha, IDG World Expo, (800) 225-4698 or (508) 820-8628.

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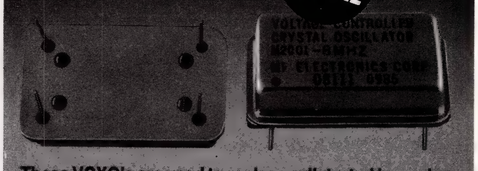

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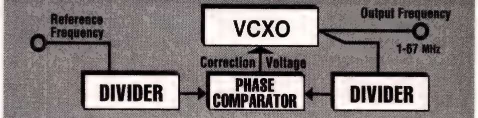

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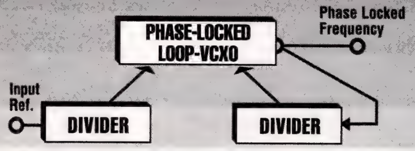

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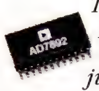

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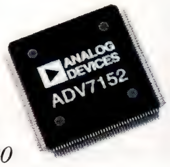

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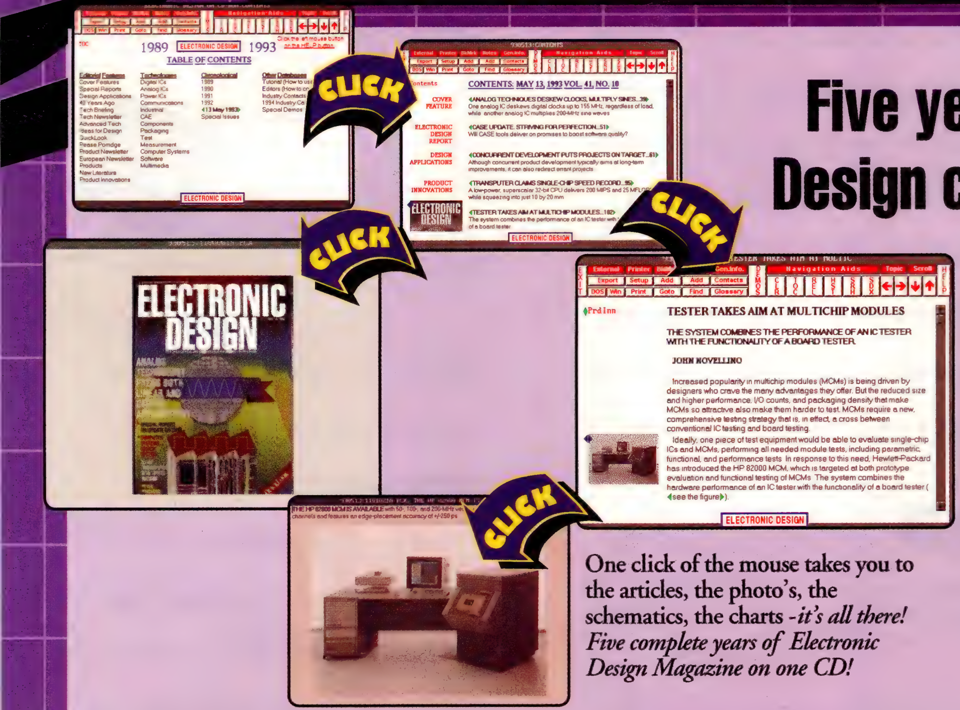

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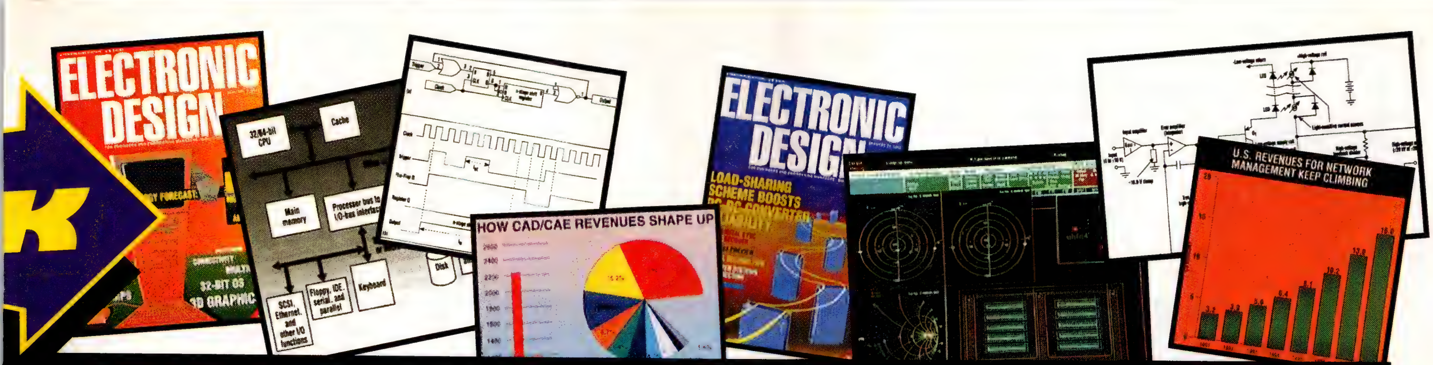
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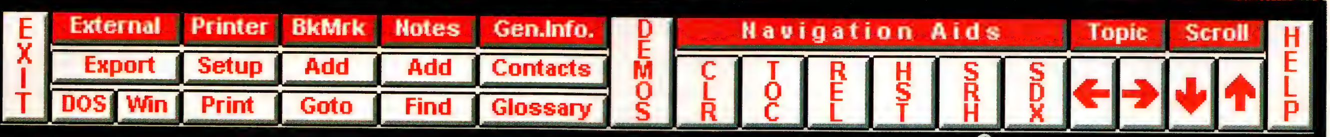

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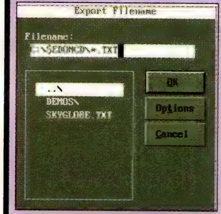
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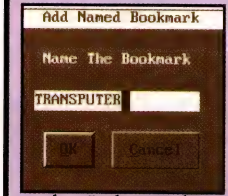
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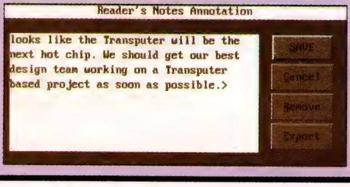
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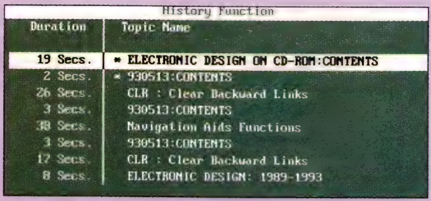
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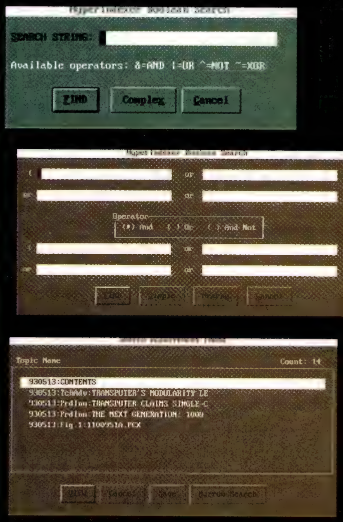
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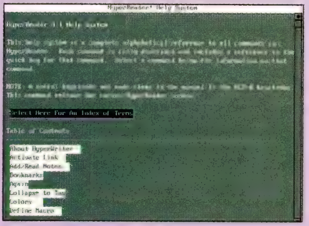
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COOPERATION

Don't look now, but I think the semiconductor industry is getting ready to take the next step in its steady march toward more and more cooperation. Over the past decade, we have seen national and regional consortia take root around the world.

It appears that the consortia want to explore the advantages of working together in certain key areas. The reasoning behind this initiative is that if precompetitive research works within nations, it can work just as well between nations. On the other hand, one might ask: If the purpose of national consortia was to provide a competitive edge for the nation, how can cooperation between consortia serve that goal?

Since the buzzword used to justify national consortia is "precompetitive research," then its analog for global cooperation will be "precompetitive precompetitive research." This concept will take a little time to digest.

But before we charge off into a tirade against technology-policy new-speak, let's look at exactly what Richard C. Johnson, Sematech's director of planning and technology transfer, actually proposed in his keynote address at the 1994 SEMI Consortia Summit in Geneva.

First, he proposed jointly developing technologies that would minimize the environmental impact of semiconductor manufacturing. Second, he recommended standardizing some of the simpler manufacturing steps. (I guess this would make it easier to standardize manufacturing equipment.) Lastly, Johnson suggested that the consortia agree on the size of the next large silicon wafers. This step alone could save billions of dollars compared to developing three different next-generation wafer sizes.

Clearly, the first group to benefit from these suggestions, if they're adopted, would be the companies that manufacture semiconductor equipment. Working our way down the food chain, IC houses worldwide would *presumably* benefit from lower equipment costs, which would *make it possible* for them to charge less for their ICs. That, in turn, would make it possible for systems companies to charge the consumer less for their products.

For countries with consumer-based economies, such as the United States, this represents an example of the "trickle-down" theory of economics. Two questions do arise, though. First, how much will actually trickle down? Second, does it give an unfair advantage for countries with manufacturing-based economies?

Jack Shandle

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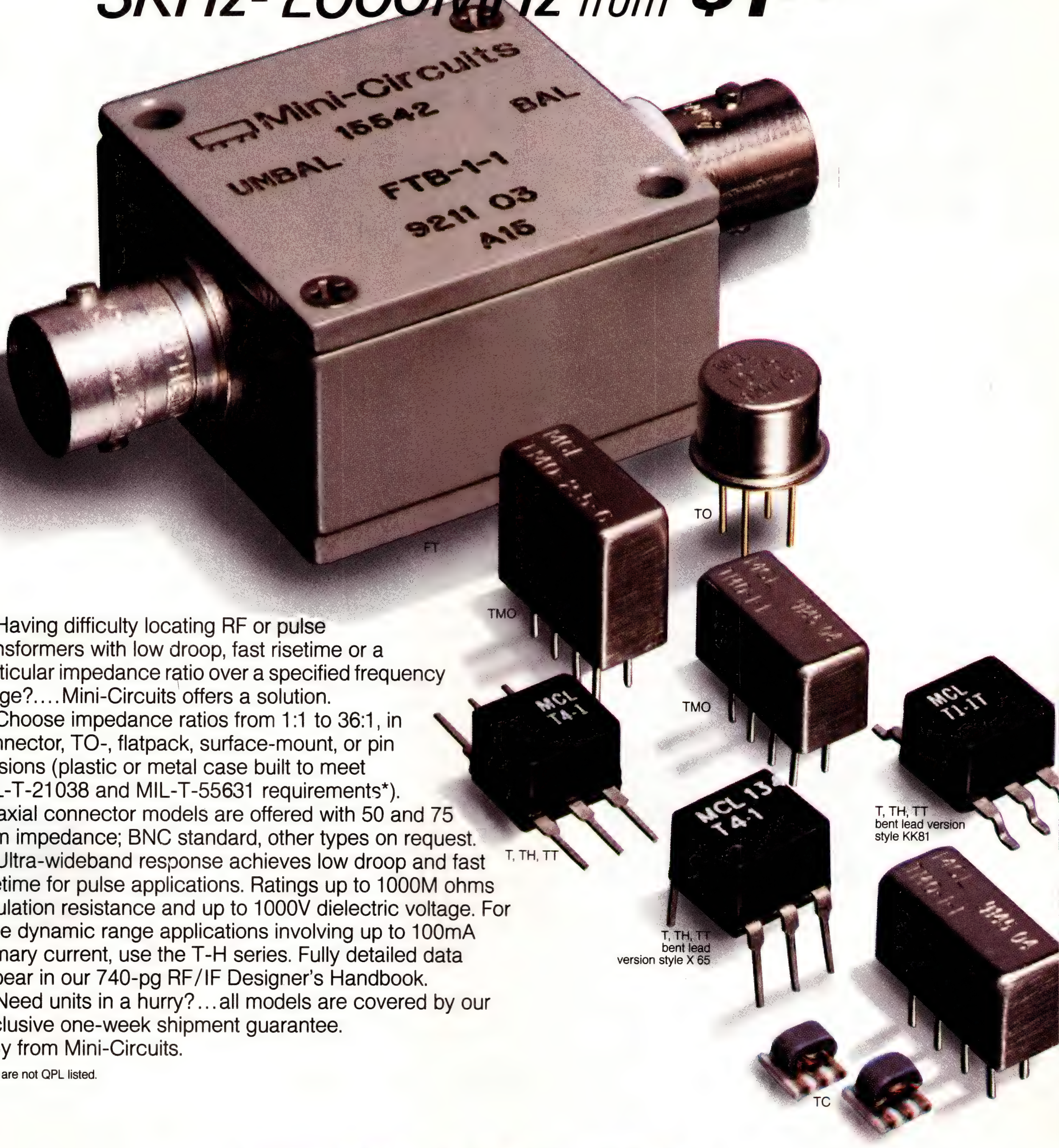

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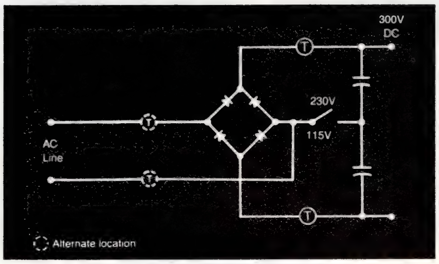

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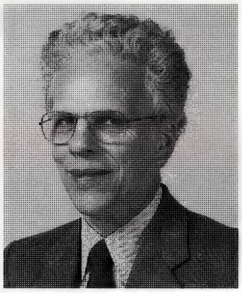
READER SERVICE 112

FAST FETS/IGBTS NEED FAST RECTIFIERS

As Lee Goldberg observed in this column back on June 13, coming to his new job with *Electronic Design* from a conservative venue like the aerospace industry (where 10-year-old designs are the rule) is like getting on a time machine. Lee will soon discover that doing our job on a day-to-day basis is like a continuous ride in a time warp.

But there are times that one tends to become jaded. In fact, I realized that I had fallen into such a trap while writing a special report on semiconductor power switches, the first one I've done in over five years (covering MOSFETs and insulated-gate bipolar transistors in particular, it will appear in the first September issue of *Electronic Design*).

The changes since my last report are monumental. At that time, although the power DMOSFET was starting to take over the tasks of the power bipolar junction transistor (BJT), the IGBT was just arriving on the scene after a long and arduous gestation period. However, the device was slow, tended to latch up, and needed an external, parallel diode in most applications. About the only packages available were the ubiquitous (albeit hermetic) TO-3, and the TO-220. Surface-mount packages were awaiting the time machine.



FRANK GOODENOUGH
ANALOG & POWER

True, the advent of the power FET brought lower conduction losses (at low voltage), and easier drive than that offered by power BJTs. However, the FETs also tantalized designers of power-control circuits (switching regulators, motor-controllers, solenoid drivers) by offering them the chance to shrink the size of passive parts by running at higher frequencies—above 50 to 100 kHz.

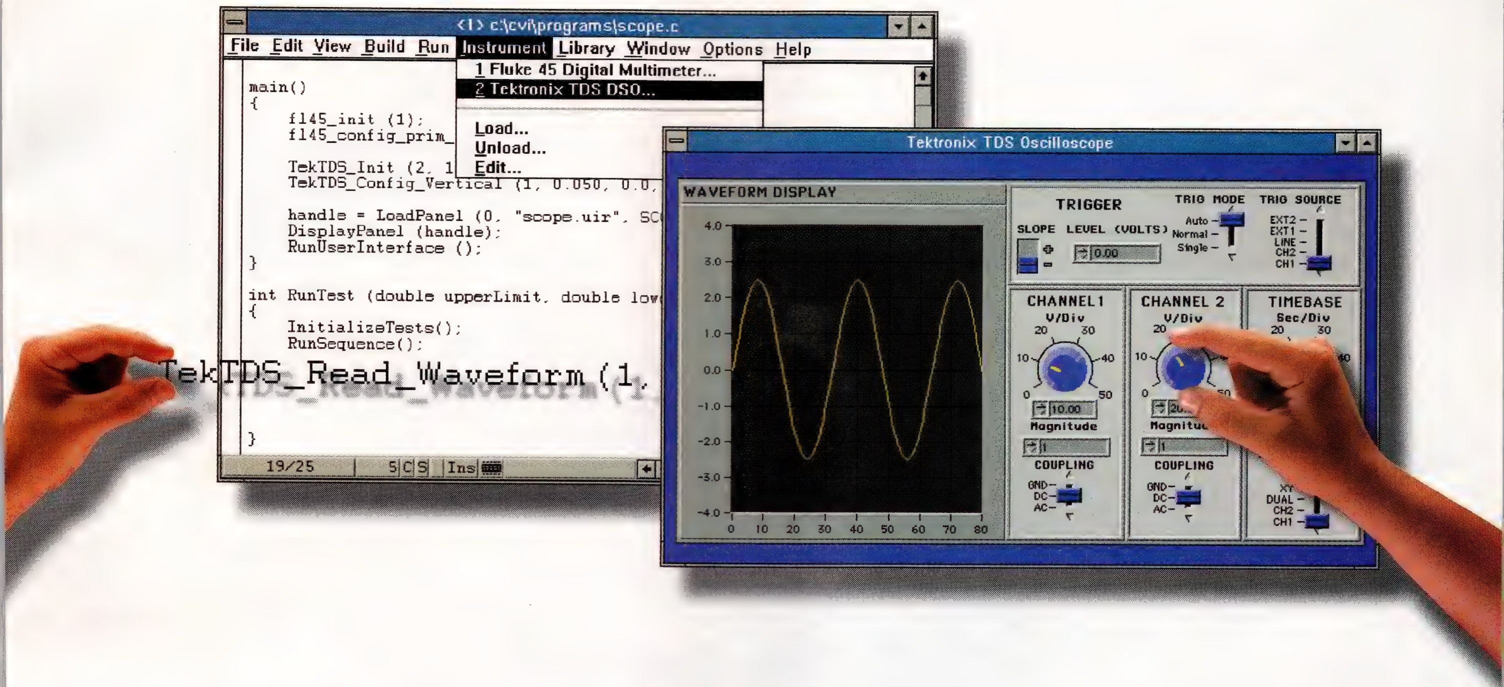
Brave souls who tried it at these frequencies soon found they needed faster rectifiers. The recovery time of available silicon devices was abysmal, increasing switching losses (decreasing efficiency) and stressing the FETs. In addition, those rectifiers that did offer fast reverse recovery didn't recover "softly," causing nasty EMI. While the FETs' "parasitic" drain-to-source, body-drain diode could do the job in some slow applications, it was usually slower than the FET by a factor of 10. A few couldn't handle the FETs' current. As if this weren't enough, the oncoming IGBT, although slow, didn't even have a diode. Thus, external devices were required.

This is one of those cases where the industry saw a market and responded quickly. And the response continues. Solutions came from several directions. They redesigned the FETs, upping the speed of the diodes to equal that of the FET, as well as raising their current-handling ability where needed. Today, most power-FET suppliers offer a line of FETs equipped with inherently-fast integrated diodes.

But, many high-volume applications, such as switching regulators, need separate rectifiers. The industry responded with power Schottkys for voltages from 5 to 200 V. Below 50 V, they "do the job." Above 50 V, losses start to increase. When at very low voltages (5 V and below), the FETs themselves, running as synchronous rectifiers, replace the Schottkys. For voltages above 100 V, all major MOSFET suppliers are offering lines of pn-junction rectifiers with fast, soft recovery. Harris Semiconductor calls them Hyperfast rectifiers, Motorola calls them Ultrafast rectifiers, and Advanced Power Technology, International Rectifier, and IXYS dub them FRED (fast recovery epitaxial diode) rectifiers.

The soaring demand for higher voltage, current, and speed also creates a greater need for faster, softer-recovery, high-voltage rectifiers. The problem is exacerbated by the advancing speed of IGBTs, which will soon exceed 200 kHz. Hope is at hand, though. Before the year is out, the start of a family of high-voltage GaAs rectifiers with virtually no recovery-time losses is expected to emerge.

Get Interactive!



```
main()
{
    f145_init (1);
    f145_config_prim_

    TekTDS_Init (2, 1
    TekTDS_Config_Vertical (1, 0.050, 0.0,

    handle = LoadPanel (0, "scope.uir", SC
    DisplayPanel (handle);
    RunUserInterface ();
}

int RunTest (double upperLimit, double low
{
    InitializeTests();
    RunSequence();
TekTDS_Read_Waveform (1,


}
```

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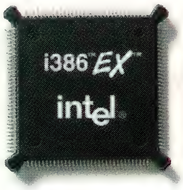
Introducing the fir for embedd



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And designing with an embedded Intel386 processor

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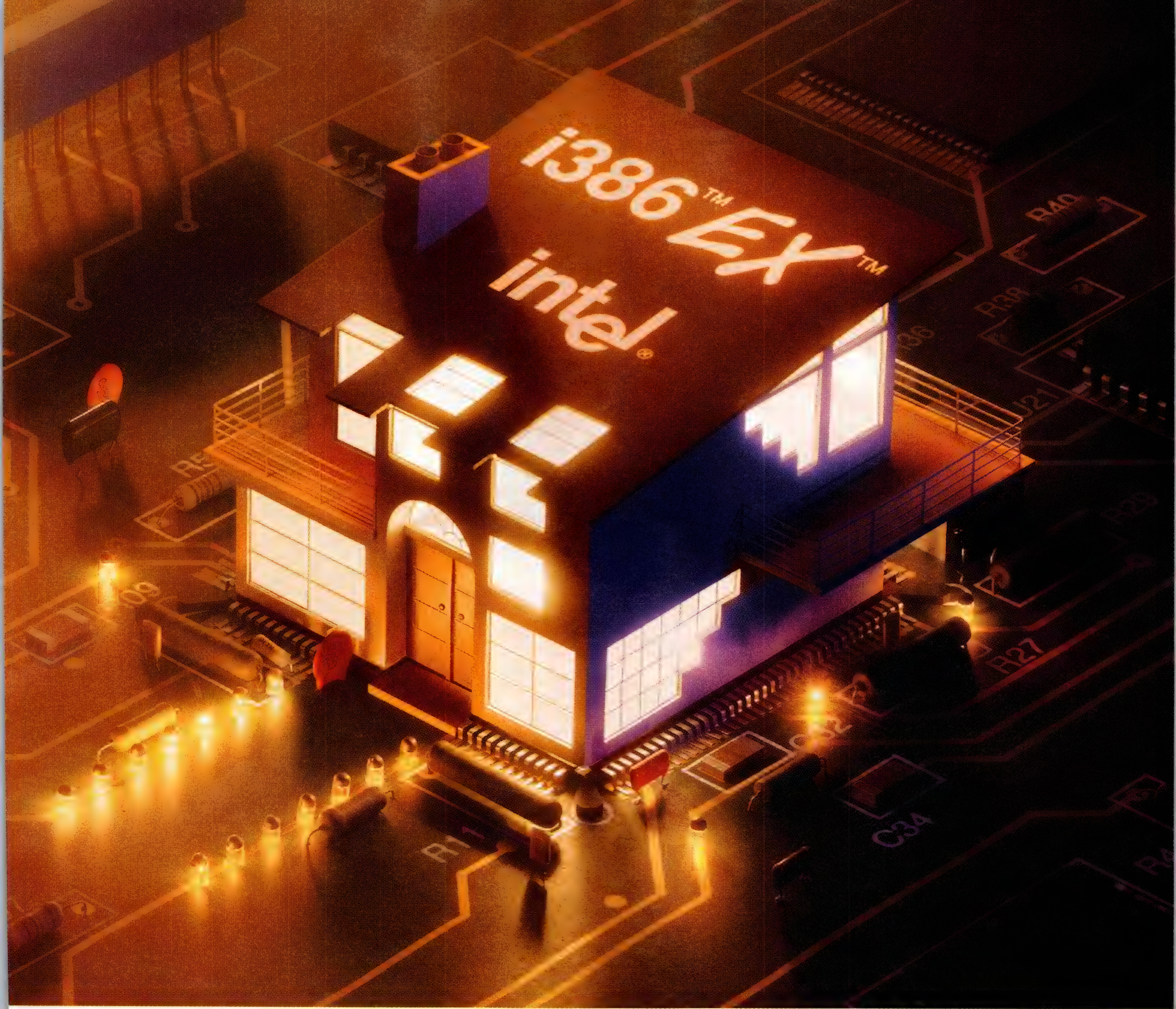

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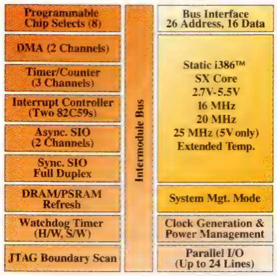
Embedded Intel386™ EX Processor Block Diagram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Interrupt Controller (Two 82C59s)
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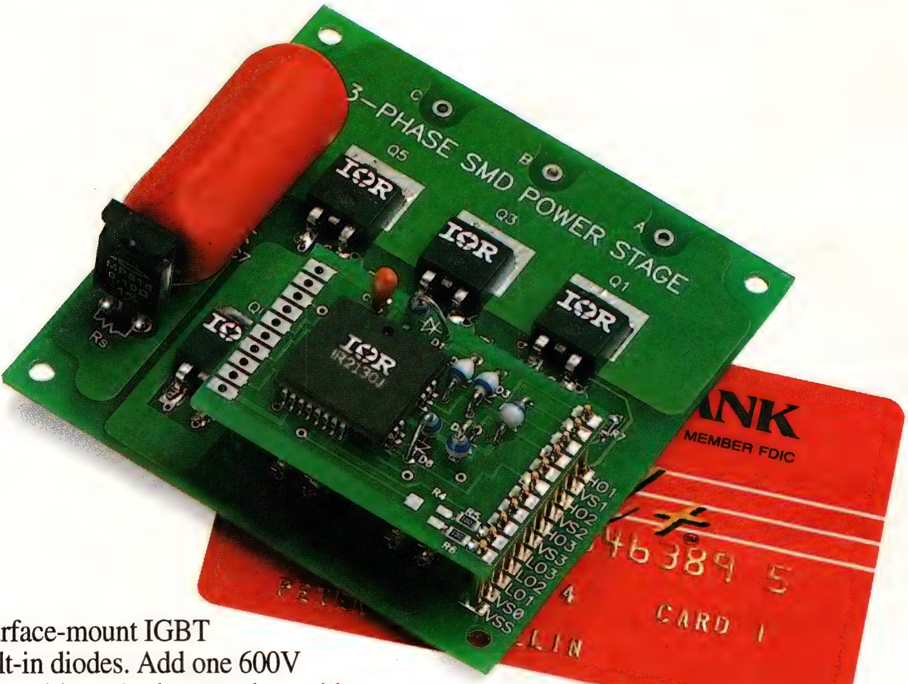

This motor control inverter is 3" x 3" sq. and features six SMD-220 surface-mount CoPack UltraFast IGBTs driven by a single 600-volt, 3-phase driver (IR2130J) with current-sensing.

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TECHNOLOGY NEWSLETTER

ARPA PROGRAM PUSHES AUTO ACCELEROMETERS

Two years ago, Analog Devices announced the ADXL50, the first ±50-g surface-micromachined accelerometer—complete with signal conditioning circuits—on one silicon chip. It's designed to replace the multiple electromechanical sensors that fire most automotive air bags. The accelerometer is going into 1994 models of the Saab 900 and is expected to soon appear in U.S. vehicles. Ray Stata, chairman and c.e.o. of Analog Devices, says his company poured over $20,000,000 into the program and will add significantly to that this year. Dr. Kaigham Gabriel, program manager at ARPA (Advanced Research Projects Agency), announced that Analog Devices had won a $3,400,000 award under the Federal Technology Reinvestment Project for development of next-generation Micro Electro Mechanical Systems, of which the accelerometer is an example.

Over the last two years, the designers of the original ADXL50 created a number of "test chips" for different applications. These applications include Z-axis accelerometers, which sense acceleration perpendicular to the chip (the ADXL50 senses acceleration in the plane of the chip), angular rate sensitive accelerometers, monolithic micromechanical filters, oscillators, and flow sensors. *FG*

OS SOURCE CODE RELEASED FOR POWERPC

Engineers developing embedded applications for the PowerPC 603 microprocessor may gain a time-to-market edge with this month's release of Lynx OS source code and a porting kit for the 603. The release comes before wide availability of the 603 chip. Lynx Real-Time Systems, Los Gatos, Calif., worked with CETIA, a subsidiary of Thomson-CSF, to port Lynx's real-time operating system to the PowerPC processors. In its OS modules and drivers, Lynx is supporting IBM Corp.'s PReP (PowerPC reference platform) specification, which is intended to support binary compatibility in single-board computers, desktop and server systems, and modules for embedded and non-embedded applications. For cross-development, the porting kit will initially be hosted on IBM's AIX operating system, which includes GNU C++ and C compilers and a GNU source-level debugger. Early next year, the kit will run on Sun hosts, along with a self-hosted environment where Lynx OS will run on PReP-compatible systems and Motorola's MVME1603 and 1604 CPU boards. *SVT*

SOFTWARE SUPPORTS PCMCIA FLASH FILES

A recently released software package, dubbed TrueFFS version 3.2, is able to support flash-file systems from a variety of flash-memory components currently on the market. The software, developed by M-Systems Flash Disk Pioneers of Santa Clara, Calif., is based on the pending PCMCIA Flash Translation layer (FTL) standard and will enable compatibility and portability of user data on flash cards across computer platforms. It optimizes system performance with read speeds exceeding 2 Mbytes/s and virtually the fastest possible write speeds. It provides 100% emulation of magnetic disks, high performance with a small memory footprint, and high data reliability, thanks to a physical-error-recovery mechanism that keeps the effects of any error localized. In addition, the design of TrueFSS minimizes the need for a PC's limited memory resources. With an included wear-leveling algorithm designed to tackle challenging situations of static areas and non-total recall, the wear of the Flash components are evenly spread throughout the Flash medium. TrueFSS is compatible with all major versions of PCMCIA software, as well as the FTL Flash File Standard. For further information, contact Jeff Williams of M-Systems at (510) 505-9081. *CA*

IEEE P996.1 STANDARD NEARS COMPLETION

Efforts are currently underway by the IEEE—with the PC-104 Consortium, Mountain View, Calif., acting as liaison—to standardize a reduced form-factor implementation of the original IEEE P996 (published in 1992) specification for the PC and PC/AT buses in embedded applications. The new standard, P996.1 Standard for Compact Embedded-PC Modules, using as its base the PC-104 specification, defines a compact, 3.6-by-3.8-by-0.6-in. modular version of the PC/AT bus. This version, the PC-104 module, can either be stacked (eliminating the need for backplanes or card cages) or plugged into custom circuit boards. The relaxed 6-mA bus-drive capability of the PC-104 module provides for low power consumption (1 to 2 W/module), thereby minimizing component count. The modules are available with 64- and 40-contact male/female headers. P996.1 is

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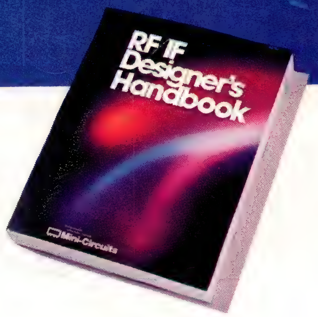

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undergoing formal IEEE balloting, and it's hoped that it will gain full approval later in the year. For additional information, contact Rick Lehrbaum of the 996.1 Working Group at (408) 522-4823. For a free copy of the PC/104 specification and Resource Guide, contact the PC/104 Consortium at (415) 903-8304. *CA*

ASIC TO SPEED UP STD 32-BUS DESIGNS

A STD 32 Application Specific IC is currently being developed by the STD 32 Special Interest Group (SIG 32), Los Angeles, Calif. The ASIC is intended to speed the design of new STD 32 products and simplify the porting of existing designs from other computer architectures, such as PC/AT bus. Early development work suggests the ASIC will feature a variety of new capabilities. Besides its plug-and-play capability, the ASIC will feature hot-swap technology, particularly useful in fault-tolerant systems, which allows a board to be removed and replaced while the system power is on. The STD 32 development committee is working with other computer manufacturers and users to incorporate the optimum feature set into the ASIC. If all proceeds well, the ASIC could be available later this year. For further information, contact the SIG 32 office at (310) 477-9664. *CA*

THE PUSH IS ON TO DEVELOP FERROELECTRICS

As part of a basic research project initiated in 1991, Matsushita Electronics Corporation (MEC), Osaka, Japan, and the University of Colorado in Colorado Springs joined forces to develop and further research ferroelectric technology. The concept for the technology, originally suggested by Dr. Carlos A. Paz de Araujo, a professor at the University of Colorado, is based on the integration of semiconductor and ferroelectric principles. Future applications of this technology lie in the development of key devices, such as telecommunication terminals, portable telephones, RF-ID tags, and ferroelectric nonvolatile memories. In addition to the ongoing research, attempts are being made to commercialize ferroelectric technology with the help of Symetrix Corp., Colorado Springs. More recently, a licensing agreement was granted to Motorola, Phoenix, Ariz., to be used in a number of its organizations, including the company's Semiconductor Products Sector (SPS), and its R&D organization in Japan. For more information, contact the Matsushita News Center at (201) 392-6067. *CA*

SENSOR HELPS STORE 20-X MORE DISK DATA

Scientists at IBM's Almaden Research Center, San Jose, Calif., claim to have developed the most sensitive sensor for detecting data on magnetic hard disks. By using the sensor, up to 20 times more data (10 Gbits/in.^{2}) can fit on a disk. Called a spin-valve head, the sensor is at least five times more sensitive than current products. The valve is based on the giant magnetoresistive (GMR) effect, which occurs in multilayer structures of very thin films (5 to 100 Å each). The valve offers an electrical signal of 0.001 V/μm of track width. As a result, designers can choose either to pack more bits into a given area of disk surface, or relax other design constraints to increase performance, such as a faster data rate (by spinning the disk faster) or ruggedness and reliability (by flying the head further away from the disk). Overall, the spin valve reduces the magnetic bit-track width from 3 to 0.5 μm. IBM expects this new technology to be incorporated into products by the end of the century. For more information on the spin-valve head, contact IBM at (408) 927-1283. *RN*

SENSOR CONVERTS LIGHT TO DIGITAL FORMAT

A recently introduced sensor that converts light intensity directly to digital data integrates photodiode, operational amplifier, and analog-to-digital-converter functions on one chip. Developed by Texas Instruments, Dallas, the sensor consists of a programmable photodiode and a current-to-frequency converter, which transforms the current output of the light-sensitive photodiode to a digital-compatible pulse train of frequency proportional to the incident light intensity. The TSL230 can be used for portable, battery-operated, and other low-cost microcontroller-based systems. It features low power consumption, 5 mW at 3 V, and operates from a 3- to 6-V power supply. Using an electronic aperture technique, sensitivity is pin-programmable to either a 1X, 10X, or 100X, effectively creating a 160-dB measurement range. The sensor's potential applications include environmental monitoring systems, process-control systems, pollution monitoring, color sensing, light reflection, and photographic exposure control. Additional information can be obtained by contacting Texas Instruments Inc.'s Literature Response Center at (800) 477-8924, ext. 4500, reference source code SLB08XNR405P. *CA*

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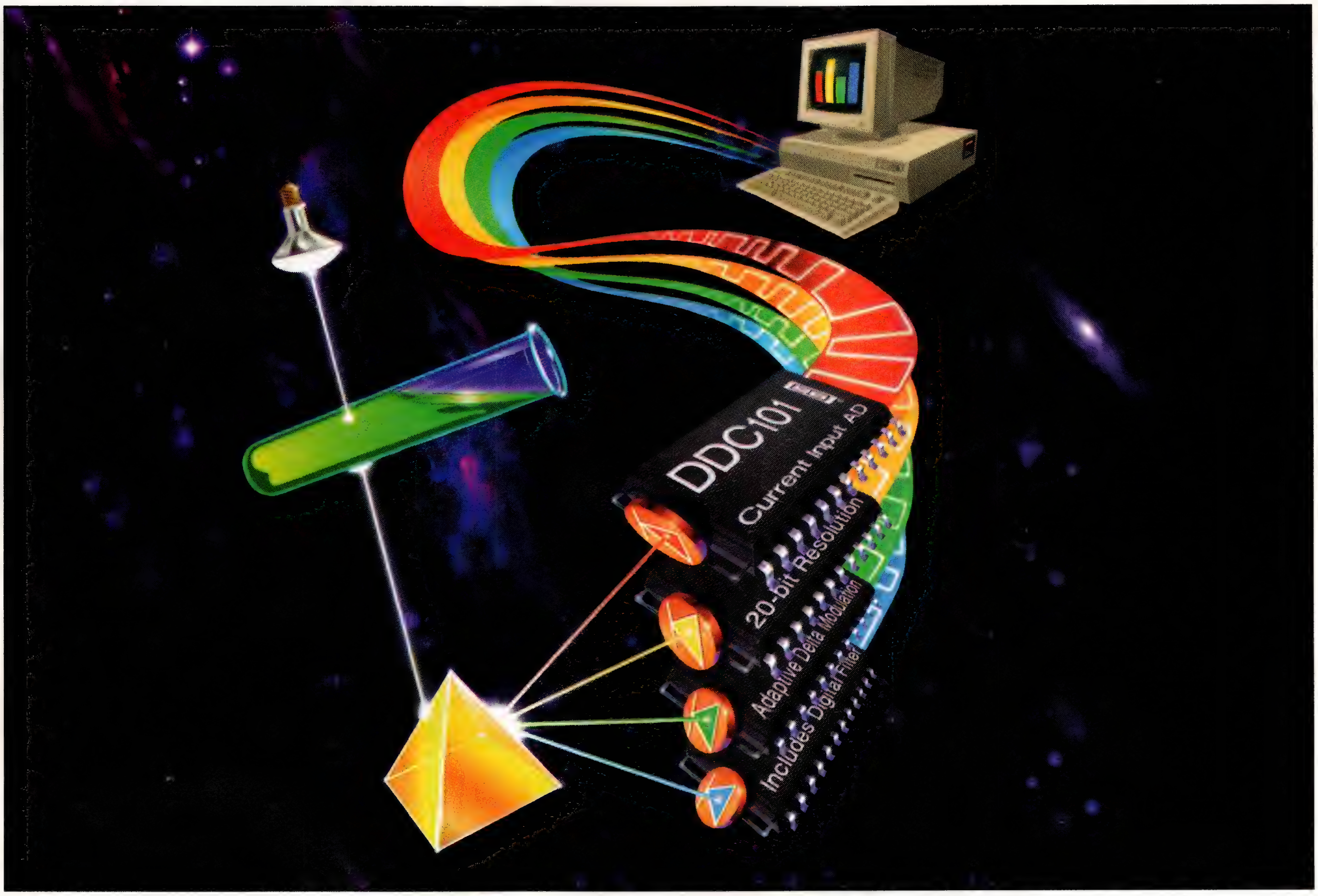

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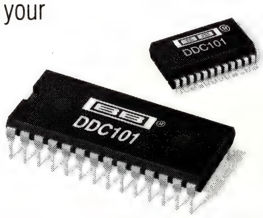

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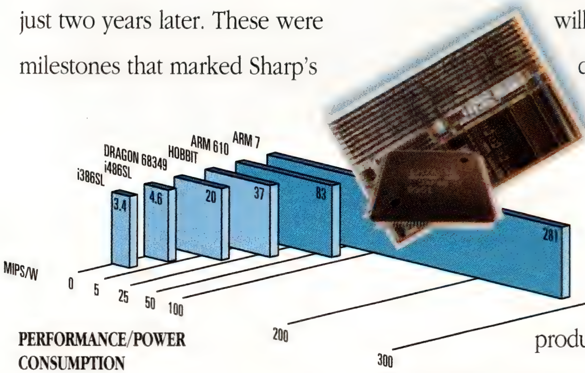

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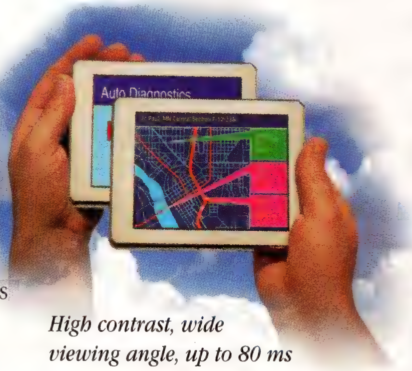

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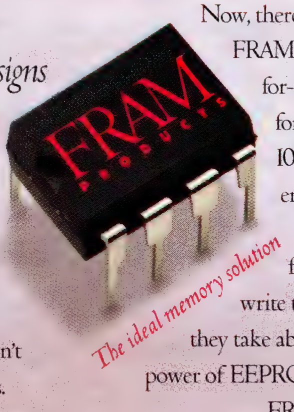

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LOW-COST WIDEBAND SPREAD-SPECTRUM DEVICE PROMISES TO REVOLUTIONIZE RADAR PROXIMITY SENSORS

An innovative implementation of both pulse echo and radar technologies have made it possible to create a revolutionary proximity sensor. The device, developed by Tom McEwan at the Lawrence Livermore Laboratory, Livermore, Calif., overcomes many of the drawbacks of conventional proximity sensors yet costs orders of magnitude less. The development comes on the heels of a recent decision by the U.S. government to seek a global leadership position in sensors, spurring new reasearch and development activity into application-specific sensors.

One example of the sensor's usefulness can be seen in automobiles. For a minimal price increase over conventional automobiles, a car's side mirrors equipped with such a proximity sensor could alert the driver when another car is close or within the driver's blind spot. This frees drivers from having to continually turn their heads and instead concentrate on looking ahead. If necessary, the sensor can activate side-impact air bags.

The sensor also can accurately and quickly detect someone trapped in the rubble of a building as a result of a severe earthquake or other disaster by detecting their breathing, instead of having to rely on a trained dog for rescue. The sensor can work through concrete, metal or wood.

The new noise-coded, wideband, and spread-spectrum proximity sensor with a sensitive pulse-detector circuit boasts a manufacturing cost of less than $10 each. That's approximately 500 times less expensive than the cost of existing radar technology systems, and can be powered by a single 9-V battery for a period of over two years.

Conventional proximity sensors, whether of the passive infrared, active beam-interruption infrared, ultrasound, or microwave-Doppler variety, are all perfectly viable solutions for use in motion detection. However, they don't work for a wide variety of applications and are plagued by problems.

The passive infrared sensor, for example, is typically the most preferred type because it's inexpensive, difficult to defeat, and can run on batteries for many years. But it's also prone to false alarms in sunlight or from hot objects. In addition, it can be rendered inoperable when blocked by an object, and contains a sensing element that's relatively expensive.

The microwave motion sensor, another preferred solution, emits a continuous carrier and detects the Doppler shift caused by an intruder's motion. Unfortunately, though, because the sensor lacks a range gate, it must rely on the amplitude of the Doppler signal to define maximum detection range. This method is imprecise, and the sensor can be triggered very easily. In addition, microwave sensors in close proximity can interfere with one another, have limited materials penetration, detectable emissions, and expensive microwave diodes and fixtures.

That's why Tom McEwan decided to take a fresh approach to proximity sensing by developing a means of combining ultra-wideband impulse radar and sensor technologies. This approach focuses on detecting the echoes that reflect back over a defined range from continually propagating electromagnetic impulses. Effectively, this produces a radar system that's so sensitive it can even detect human breathing. Furthermore, the sensor is unhindered by most materials, making its location no longer a key factor in its ability to work properly.

Along with its low cost, the radar-based proximity sensor features a number of other desirable advantages. Not only can it can "see through walls," it also can distinguish for example, between the different materials that make up the wall, whether the material is made up of wood or is a metal.

Its insensitivity to object temperature and lack of a sensing element make it ideal for any type of application. In addition, because the radar noise is coded, an unlimited number of sensors can be co-located without interfering with each other.

In fact, the probability that two co-located sensors will interfere with one another is roughly 0.01%. Adding more proximity

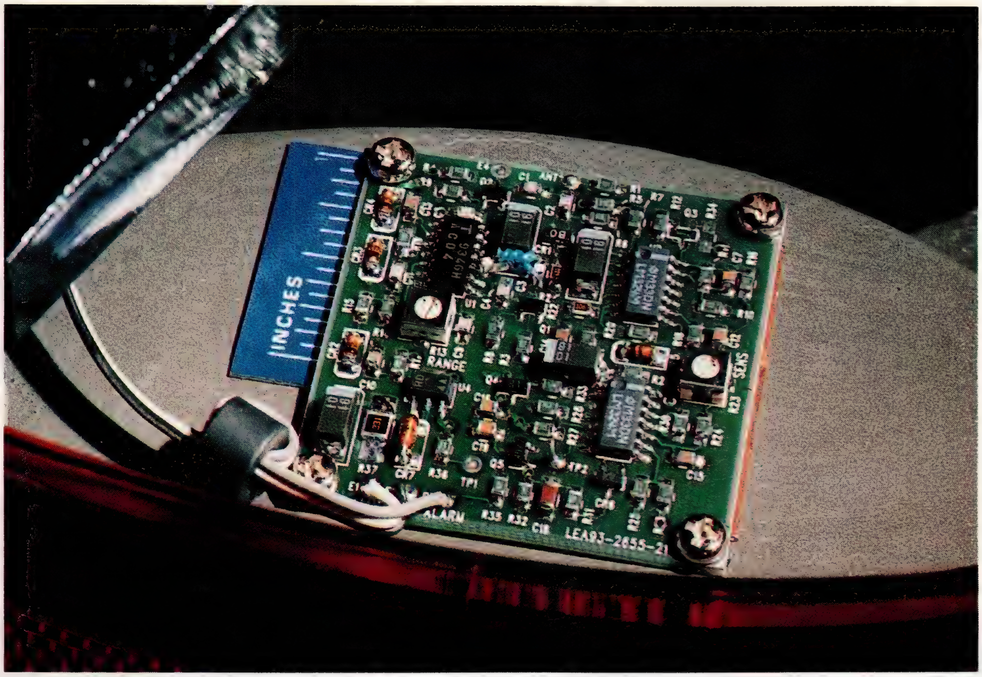
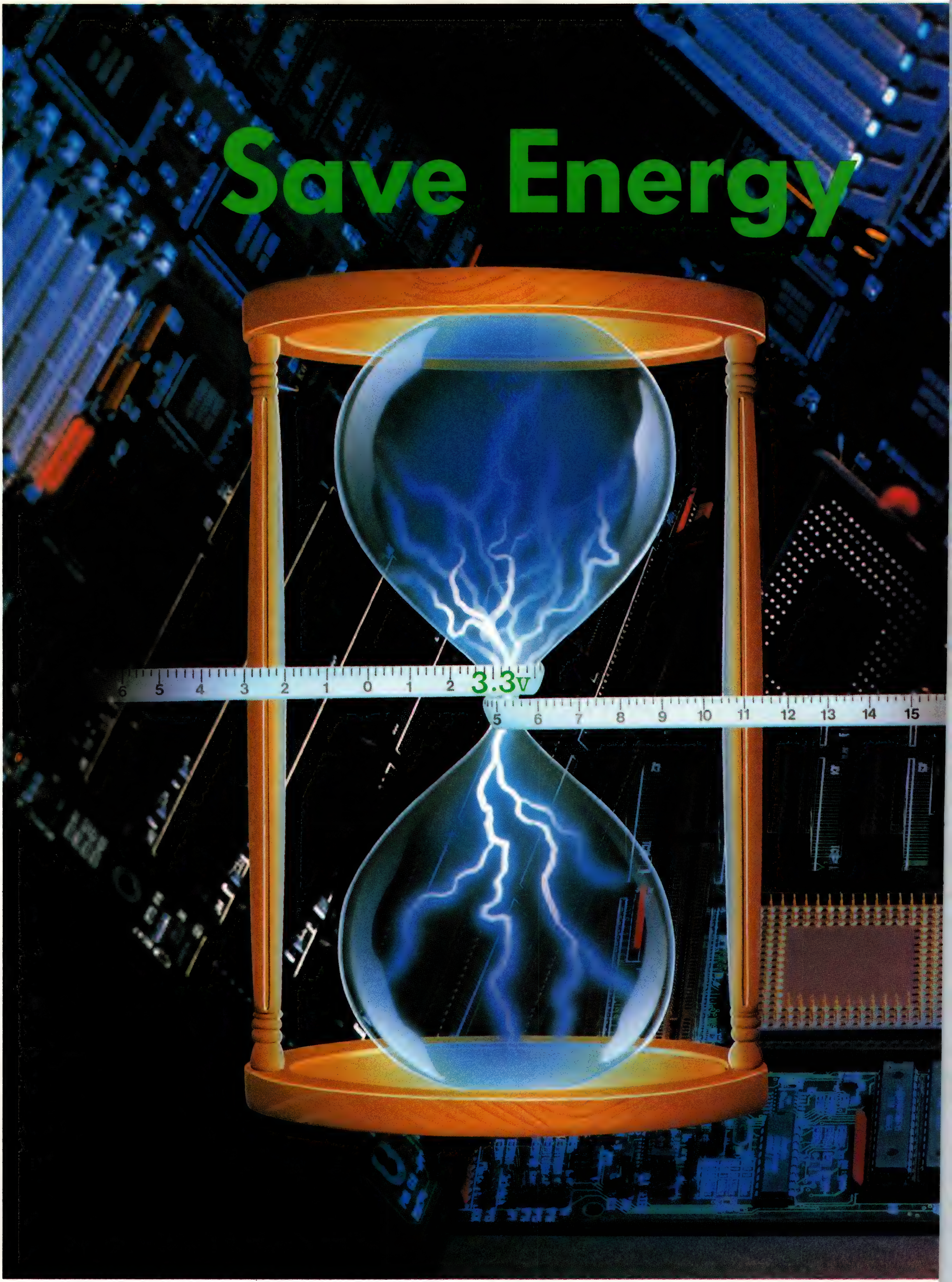


Fig. 1



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HY514260B HY514460B	256K x 16, 2/CAS 256K x 16, 2/CAS WPB	L/P, S/R 512 Ref.	40 SOJ 40/44 TSOP-II	
HY51V4260B HY51V4460B	256K x 16, 3.3V 2/CAS 256K x 16, 3.3V 2/CAS WPB			
HY514170B HY514370B	256K x 16, 2/WE 256K x 16, 2/WE WPB	L/P, S/R 1K Ref.	40 SOJ 40/44 TSOP-II	
HY51V4170B HY51V4370B	256K x 16, 3.3V 2/WE 256K x 16, 3.3V 2/WE WPB			

Note: 1. All types are Fast Page Mode
2. WPB: Write per Bit, L/P: Low Power, S/R: Self Refresh

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sensors decreases this probability at a geometric rate.

With all of these advantageous features, it seems hard to believe that the sensor, which consists of two transmission circuits and receiving sensors, is contained on a pc board that measure approximately 1-in.^{2} *(Fig. 1)*. It's estimated that one day this sensor will be built on a single ASIC fabricated by a 1- to-3-µm CMOS process, in combination with a few silicon wideband components. And since some ASIC companies are currently collaborating on this effort, that day may arrive sooner than expected. Even those who fear the effects of radiation emissions won't object to the sensor, because the amount of radiation it emits is 1 million times less than that emitted by a cellular telephone.

The key to the radar-based proximity sensor is a patented receiver that can detect echoes of rapid and wideband radar pulses (about one million per second) reflected from objects at distances from 0 to 200 feet. This receiver, when combined with a transmitter, forms the basis of the radar sensor's operation *(Fig. 2)*.

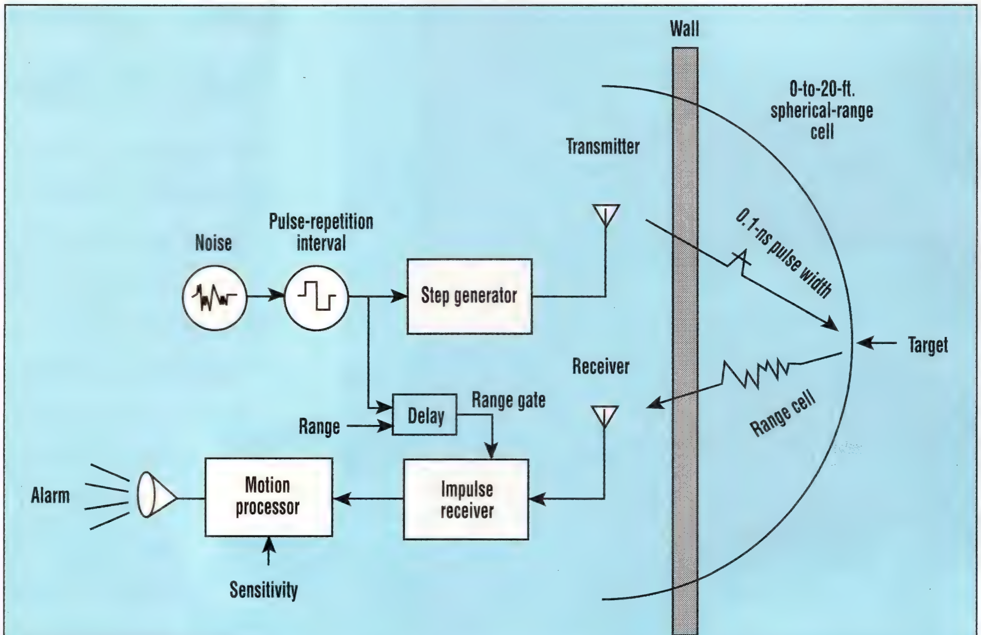

Fig. 2. Basic radar sensor schematic

The proximity sensor's transmit antenna emits a subnanosecond pulse at a noise-dithered repetition rate. The pulse is adjustable from 50 ps to 50 ns. The dithering randomizes the time of the emission, creating a spread spectrum that looks like random noise to other detectors. As the pulse propagates outward, reflections from objects in the surrounding environment return a complex series of echoes to the receiver antenna. Because the time of the pulse is set, the sensor's detector, which typically samples at a frequency of 1 MHz, listens at the appropriate time for the echo.

The received signal, in fact, is very weak, so approximately 3000 pulses are sampled and averaged to improve the signal-to-noise ratio. Using this design, only fluctuating signals are allowed to pass through the receiver.

As an object or person comes into the area defined by the range gate, an amplified signal from the impulse receiver fluctuates and trips a threshold detector circuit in the motion processor to provide some type of alarm signal. Only fluctuating signals pass through the receiver circuit. As a result, the sensor can pick out even the slightest motion against a very cluttered background.

The lone downside to the sensor system is its short detection range of up to 20 feet, which is a much shorter distance than conventional radar systems. These latter systems can detect objects over a distance of miles.

Needless to say, the sensor wouldn't be the first choice for use in applications requiring long-range detection. However, there are still a large number of applications that don't require such a long detection range, and consumers who would rather buy 100 proximity sensors at a considerable savings than one conventional radar system to do the same job.

While many companies are currently designing this sensor into their products, the radar application is only the tip of the iceberg. Amerigon Inc., Burbank, Calif., for example, is investigating the impact this sensor will have on the automotive industry. Future products include proximity sensors for use in car security, backup warning (when other drivers get too close or are in the driver's blind spot), as a parking aid, and in voice-activated navigation systems.

Another company, Zircon International, Campbell, Calif., has plans to develop a line of electronic hand tools. One of the tools, for example, will be a specialized detector for locating steel within concrete, in effect a highly accurate and reliable stud finder. A similar tool also could be used to locate wooden studs, as well as plumbing lines and electrical wiring.

Yet another device could scan the ground to find objects buried under concrete, such as drain pipes or gas lines. Other potential applications for the proximity sensor include earthquake search and rescue equipment, proximity activated toys, intelligent appliances, lighting control, musical instruments, industrial safety systems, and even robotics systems.

It's anticipated that more applications will come to light as time goes by, but consumers may soon be reaping the benefits of this technology: Amerigon believes these sensors will start to show up in cars as early as 1997, while Zircon hopes to have their first tool available in 1995.

Contact Steve Wampler of Lawrence Livermore National Laboratory at (510) 423-3107.

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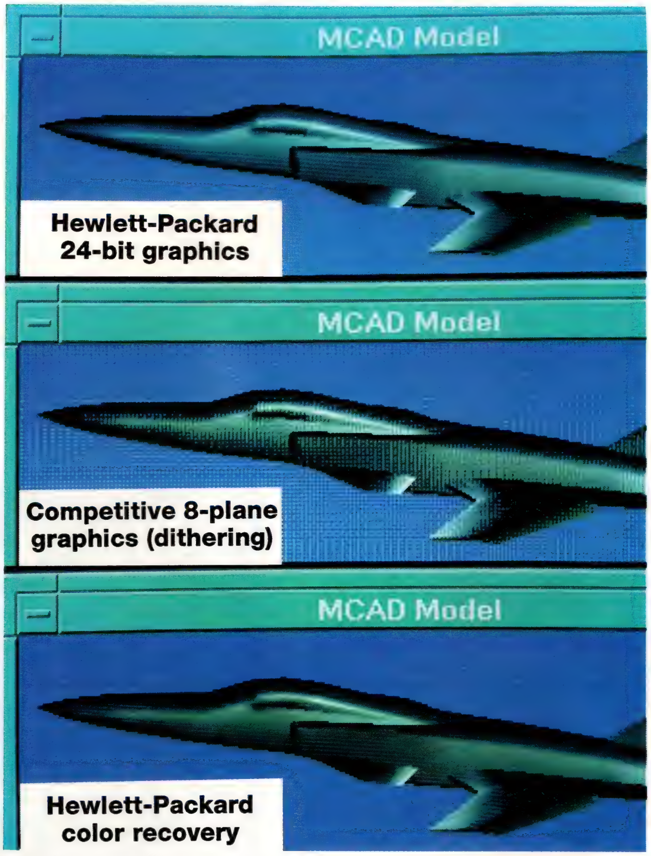
COLOR-RECOVERY SCHEME LETS 8-BIT GRAPHICS SYSTEMS DELIVER CLOSE TO 24-BIT QUALITY


MCAD Model
Hewlett-Packard 24-bit graphics
MCAD Model
Competitive 8-plane graphics (dithering)
MCAD Model
Hewlett-Packard color recovery

A novel color-recovery scheme allows 8-bit graphics subsystems to deliver close to 24-bit color images. Developed by engineers at the Workstation Products Division of the Hewlett-Packard Co., Chelmsford, Mass., the scheme employs a smart dithering algorithm executed on a digital-signal processor embedded in the graphics controller, as well as a color-recovery decoder that's included as part of the RAMDAC typically located in the controller *(see the figure)*. Traditionally, 24-bit true-color images have been obtained using a "brute force" method. This approach adds more hardware to a system, and ultimately increases system costs.

The DSP block used in the design encodes a 16-pixel cell of true-color data into an 8-bit format, and still maintains a wide range of over 4 million colors with an accuracy of up to 23 bits at each pixel location. What results is a very smooth image that's hard to differentiate from a full true-color image.

Applications such as mechanical design automation, architectural CAD, geographic information systems, electronic publishing, and satellite and medical imaging all can benefit from the scheme. That's because it would allow the use of less-costly hardware.

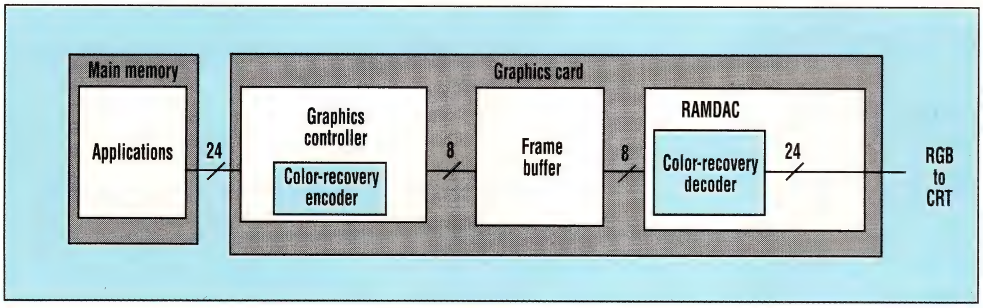
In contrast, standard dithering schemes use a cell of 16 pixels and have a color range limited to 256 colors, resulting in a grainy, cross-hatched texture *(see the photo)*. The dithering process approximates colors by intermixing pixels of two or more colors. In other words, pixels of different colors are placed next to each other so that the viewer's eye would be "tricked" into seeing a blend of the colors (for instance, a checkerboard of red and white pixels would be perceived as a shade of pink).

Thus, without the high cost of a 24-bit frame buffer, graphics systems can still provide close to 24-bit quality by delivering millions of colors from 8-bit encoded data. In addition, many applications already have been written to allow for dithering, making it possible to simulate true color when using an 8-plane graphics subsystem. With such systems, the new color-recovery scheme also can produce improved images. Where the color-recovery scheme shows its flaws is in screen areas with low contrast—edges of polygons and vectors may show some artifacts.

The color-recovery process consists of two operations—color encoding and color decoding. A new and unique dithering algorithm is incorporated in the encode portion, while the decode portion employs specialized DSP capabilities that must be embedded in the graphics subsystem. The process starts with 24-bit color data supplied by the application program via the graphics driver. That data then is encoded down to 8-bit representations with both hardware and software.

The 8-bit values are held in the lower-cost 8-bit frame buffer until needed, at which point they're decoded back to millions of colors and displayed. The decoder only operates on pixels marked as being encoded for the color-recovery scheme.

At its peak throughput, the decode function executes up to 9 gigaoperations per second. Data is stored as a 3:3:2 encoded and dithered image (3 bits for red, 3 bits for green, and 2 bits for blue) and can be read back as a standard 8-bit image when the color-recovery scheme isn't enabled. Furthermore, the recovery dither (decode) operation doesn't affect the performance of the application and there's no noticeable difference in the speed of application execution.



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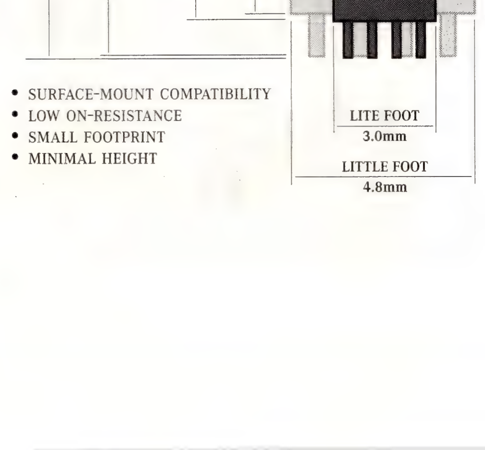

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In the encode section, graphics images that are generated by Hewlett-Packard's PEXlib (the Starbase of HP-PHIGS) and not used with virtual-memory double buffering are encoded using hardware support. However, if the scheme of virtual-memory double buffering is employed, the driver software performs the encoding. If an application was written using Xlib, encoding must be done in software, regardless of whether or not double buffering is used.

Initially, the scheme has been incorporated by the Hewlett-Packard Co. into various color graphics devices, either on the motherboard or on add-in cards, for just about all HP 700 series workstations and HCRX graphics devices. However, even if the color-recovery capability isn't enabled, these systems still will be able to view the data as 8-plane images, replete with all of the dithering artifacts.

DAVE BURSKY

FAST SILICON CHALLENGES EXOTIC TECHNOLOGIES FOR THE INFOBAHN

A recent series of studies that were conducted at Ruhr University, Bochum, Germany, demonstrated that a 10-Gbit/s information infrastructure can be built with bipolar silicon components rather than rely on more exotic solid-state technologies. The project was undertaken as a joint effort by several European R&D programs and industry leaders, including ANT-Achrichtentechnik AG, the Hewlett-Packard Co., Motorola Inc., and Siemens AG. A 10-Gbit data rate was selected as the target speed for a hypothetical "strawman" type wide-area network.

To build the gigabit link, the transmission and reception functions were broken down into chip-level blocks. Each of the circuits was developed by a team led by Professor H.M. Rein of Ruhr University at Bochum and was fabricated by the manufacturers using their existing high-speed bipolar silicon production processes. These functional blocks included a multiplexer, laser driver, a transimpedance preamplifier, main amplifier, decision circuit, demultiplexer, and a frequency divider. The multiplexer was fabricated on Hewlett-Packard's HP25 process, and the main amplifier was implemented in Motorola's Advanced MOSAIC-V process. The remaining six functions were fabricated by Siemens using their new B6HF process *(see the table)*.

While the test's transmission rate was 10 GHz, the internal speeds of the chips were much higher. The fastest of the group was the Siemens-built demultiplexer, achieving internal clock rates of up to 32 GHz. The B6HF process developed by Siemens produces transistors with cutoff frequencies exceeding 25 GHz at zero base-collector voltage, and current-mode logic arrays with delays of 25 ps at 1.2 mA and 70 ps at 100 µA.

The process makes use of a double-polysilicon structure and uses a self-aligned geometry. Fabication is being performed using 0.8-µm lithography.As a result, effective emitter width is around 0.4 mm. In the B6HF process, transistors are fabricated on a layer of arsenic-doped silicon. A boron implant forms a guard zone to prevent leakage currents under the field oxide layer. In addition, the transistor's tungsten collector plugs are implanted.

The transistor's high level of performance stems from several key processing steps. Low noise is partly due to the self-alignment scheme that minimizes base resistance. The small emitter size (0.8 by 1.1 µm) results from a triple-spacer design, which gives a biasing of 0.2 µm on both sides of the emitter. Another contributing factor is aggressive doping profiles. As an example, the emitter junction depth is only 40 nm while the base width is about 100 nm.

Siemens claims that bipolar RF circuits can be fabricated at a modest cost using their standard CMOS process with 0.8-µm design rules for many of the steps. The only additional step required by the B6HF process is the depositing of an epitaxial layer. Employing the existing CMOS fabrication technology helps reduce the startup costs for early products that are anticipated for production by

HIGH-SPEED PRODUCTION SILICON BIPOLAR ICs FOR OPTICAL-FIBER LINKS

Circuit	Maximum speed	Process	Notes
Multiplexer	30 Gbits/s (RUB and Hewlett-Packard)	Hewlett-Packard HP25	2:1 circuit
Laser driver	14 Gbits/s (RUB and Siemens)	Siemens B6HF	3.6-V swing (at 50Ω)
Preamplifier	13 Gbits/s (RUB, ANT, and Siemens)	Siemens B6HF	f_c of 10 GHz; transimpedance type with 615-Ω impedance and 10.5 pA/$\sqrt{\text{Hz}}$ noise
Main AGC amplifier	13 Gbits/s (RUB, ANT, and Motorola)	Molorola Advanced Mosaic V	S_{21} of 37 dB, f_c of 10 GHz, and dynamic range of 45 dB
Main limiting amplifier	15 Gbits/s (RUB, ANT, and Siemens)	Siemens B6HF	S_{21} of 52 dB, and f_c of 10 GHz
Decision circuit	22 and 25 Gbits/s (RUB and Siemens)	Siemens B6HF	Coherent phase modulation of 180°
Demultiplexer	32 and 40 Gbits/s (RUB and Siemens)	Siemens B6HF	1:2 circuit
Static frequency divider	19 and 25 GHz (RUB and Siemens)	Siemens B6HF	2:1 circuit with two outputs: 0° and 90°

RUB = Ruhr University, Bochum, Germany; ANT = ANT Nachrichtentechnik, Backnang, Germany; fc = cutoff frequency.
Source: "New silicon bipolar technology challenges GaAs for wireless telecom," by professor H.M. Rein, Ruhr University, Bochum, Germany.

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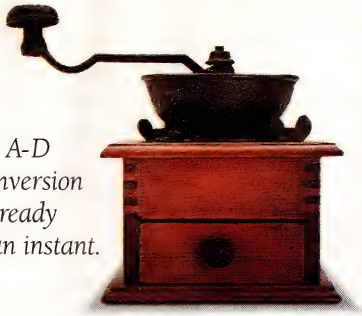

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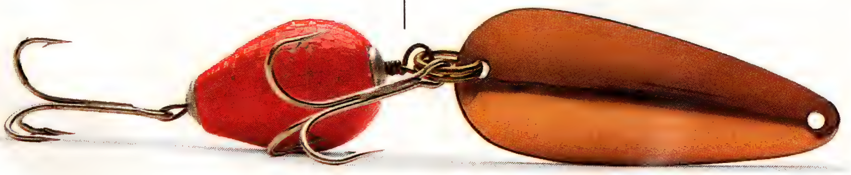

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the middle of this year.

The successful test of this 10-Gbit link gives the green light to inexpensive silicon bipolar technologies for the next generation of Infobahn data-highway hardware and some wireless RF chips previously reserved for gallium-arsenide (GaAs) and other high-speed technologies. The competition is far from over, however, as GaAs IC manufacturers are working hard to maintain their hold on the upper end of the frequency band.

Semiconductor companies like Raytheon, Rockwell, TriQuint, and Vitesse have successfully helped GaAs make the transition from military applications to the rough-and-tumble market for consumer products. They've done this through innovative engineering practices that brought GaAs chip prices within striking distance of silicon ICs while still retaining the low-noise and low-power advantages inherent in the technology.

Steve Sharp, c.e.o. of TriQuint, is confident that the physics of gallium arsenide will give it an edge over silicon in the 10+ GHz range. "The proof will be in the performance," says Sharp, noting that several manufacturers of both GaAs and silicon ICs were developing the technology for 10-Gbit products.

There is yet to be a clear winner in the intense competition for the next generation of data-pipe technology. The only certain beneficiary will be the consumer, as the price/performance ratio of communications equipment is pulled up another notch.

LEE GOLDBERG

ADVANCED TECHNOLOGY, CIRCUITS SPOTLIGHT "HOT" INTERCONNECTS AND CHIPS SYMPOSIA

Although summer in California is ideal for vacationing, heated activity in high-performance communications devices and microprocessors may require postponing any planned getaways in August. Many interesting discussions are expected next month at the annual Hot Interconnects and Hot Chips symposia, sponsored by the IEEE Computer Society. Slated for Aug. 11-13 and Aug. 14-16, respectively, at the Memorial Auditorium of Stanford University, the symposia provide previews of forthcoming technologies for data transfer and crunching.

The latest research and product developments will be covered at both conferences, with various keynotes, panel sessions, technical papers, and tutorials sprinkled throughout. At the Hot Interconnects conference, high-speed local- and wide-area networks will be one prime focus. Keynote presentations on asynchronous-transfer mode (ATM) networks and

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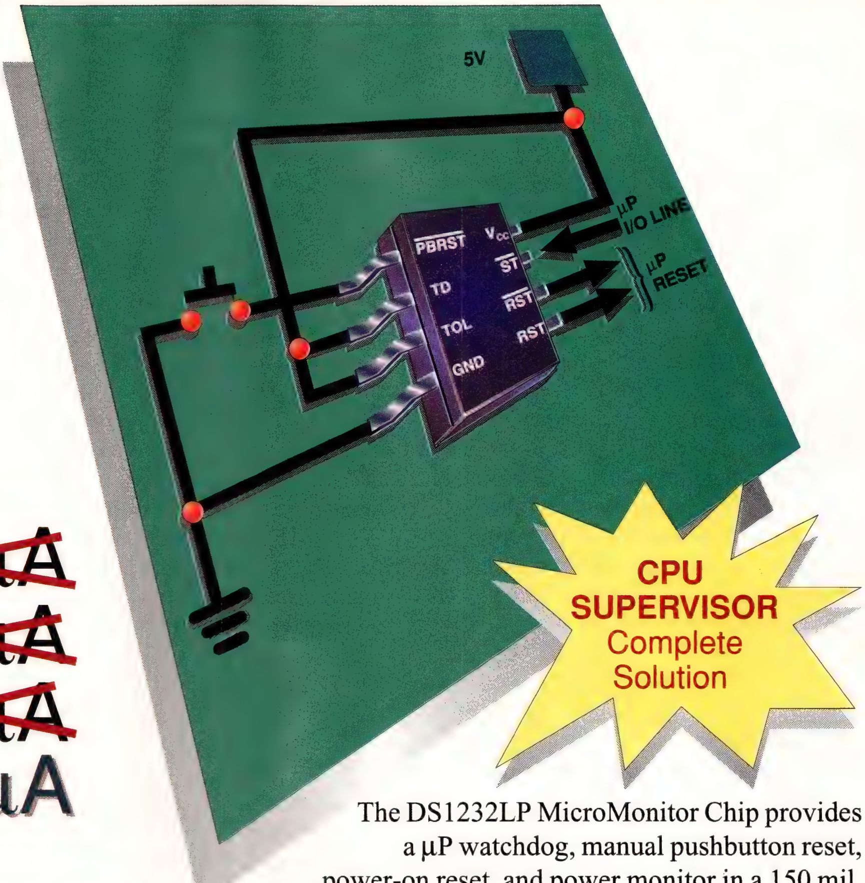

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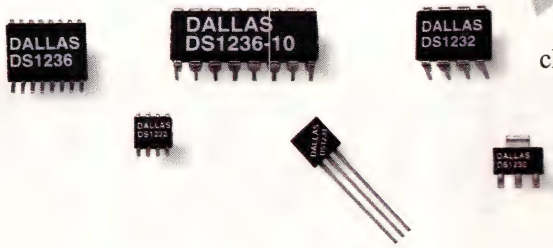

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DS1233	4.50 4.25 4.00	✓			✓				TO-92 SOT-223
DS1233A	2.80 2.64	✓			✓				TO-92 SOT-223
DS1233D	4.25 4.00				✓				TO-92 SOT-223
DS1236	4.50 4.25	✓	✓	✓	✓	✓	✓		16-Pin DIP 16-Pin SOIC
DS1238	4.50 4.25	✓	✓	✓	✓	✓	✓		16-Pin DIP 16-Pin SOIC
DS1239	4.50 4.25	✓	✓		✓	✓	✓	✓	16-Pin DIP 16-Pin SOIC
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READER SERVICE 96

gigabit/s local-area networks will be presented by Dave Sincoskie of Red Bank, Murray Hill, N.J., and Chuck Seitz of Myricom, Arcadia, Calif.

The many technical sessions address ATM hardware, routers, gigabit data links, the Fibre Channel, and PCI and other bus interconnections. Some tutorials on the morning of Saturday, Aug. 13, will include ATM Networking, an Introduction to PCI Design, and Digital Audio/Video. The Fibre Channel, as well as "the Multimedia Infrastructure and Surfing the Internet," will be discussed in the afternoon.

The Hot Chips conference reverses the sequence, hosting its tutorials on Sunday, August 14. "Algorithms and Hardware for Video Compression" is slated for the morning, while a discussion on the "Instruction-Set Extensions for Multiprocessor Interconnects" takes up the afternoon. Over the following two days, several sessions will present details of the highest-performance RISC processors yet designed—the Alpha AXP from Digital Equipment, Hudson, Mass.; the Power2+ multichip processor and PowerPC 604 from IBM, Austin, Texas; a 500-MHz, 32-bit RISC engine from NEC, Tokyo, Japan; and the Thunder SPARC-compatible processor from Metaflow Technologies, La Jolla, Calif.

Another area of discussion surrounds CISC processors. For new performance heights, they're borrowing many of the same RISC architectural enhancements, like superscalar architectures. To that end, details of the M68060 superscalar architecture will be the topic of one presentation by Motorola, Austin, Texas, while details of a low-power, high-performance version of the Pentium will be unveiled by Intel, Aloha, Calif. Both Motorola and Intel also will describe peripheral-component-interconnect (PCI) chip designs: a PowerPC-to-PCI bridge chip and a second-generation PCI motherboard chip set, respectively.

CPUs for embedded applications also will take center stage with presentations scheduled on several recently introduced designs. Included will be the next generation of i960 processors from Intel, Chandler, Ariz.; the SH-II family from Hitachi America, Brisbane, Calif.; and a family of scalable processor cores from National Semiconductor, Santa Clara, Calif.

Several papers examine multiprocessor systems and dedicated CPUs for graphics and video. Many of these developments try to solve issues that get in the way of multiprocessor communications. For instance, the Alewife cache-memory management unit will be the focus of a presentation by MIT, Cambridge, Mass. nCube, Beaverton, Ore., will describe a node processor used in its latest multiprocessor parallel-computing system. Researchers from Aarhus University in Denmark will detail a 100-kbit/s exponentiation CPU.

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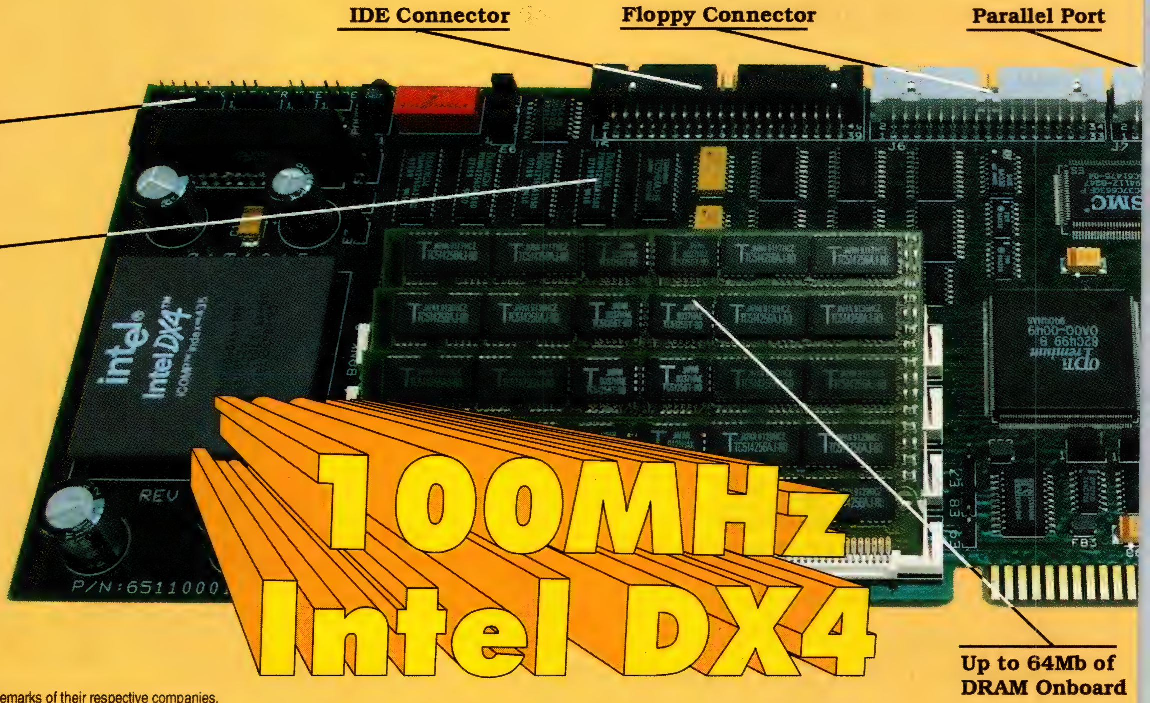
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will show off enhancements to their latest PA-RISC processor for multimedia decoding. It has architectural improvements for multimedia operations, like MPEG video decompression. Dedicated silicon for video compression, in the form of an H.320-to-Indeo transcoder, will be described by Integrated Information Technology, Santa Clara, Calif., while Array Microsystems, Colorado Springs, Colo., will introduce a programmable chip set that handles multiple compression standards. In addition, designers at Vertex Semiconductor, San Jose, Calif., will show off their novel approach to accelerating graphics. Rather than add a separate accelerator chip, they incorporated graphics acceleration functions as part of a chip set for PCI-based motherboards.

The merging of graphics and multimedia on the desktop also is causing an explosion of chips optimized to accelerate many key operations and even add 3D capabilities. DEC and Sun Microsystems, Mountain View, Calif., will examine smart frame-buffer and cached VRAM designs, respectively, to illustrate several approaches for high-performance graphics. Apple Computer and 3Dlabs, Los Gatos, Calif., will show off processors that provide real-time 3D graphics manipulation for computationally-intensive 3D graphics.

With all of the data that high-performance graphics requires, moving that data around requires equally high-performance communications interfaces. In the session on networks and communications, a GaAs-based ATM interface chip for high-speed networks will be unveiled by Thomas Neuroth, Vienna, Austria, while Inmos, Bristol, U.K., will detail its STC104 asynchronous packet switch. A biCMOS 500-Mbyte/s scalable-coherent interface IC, will be the focus of a presentation by IBM, Rochester, Minn. Qualcomm, San Diego, Calif., will detail a CDMA cell-site modem implemented on one chip.

DAVE BURSKY

WANT TO GO?

For more information on the Hot Chips conference, contact Dr. Robert Stewart at Stewart Research Enterprises, 1658 Belvoir Dr., Los Altos, CA 94024; phone: (415) 941-6699; fax: (415) 941-5048; e-mail: r.stewart@compmail.com.

For the Hot Interconnects conference, contact Dr. Quang Li, Dept. of Computer Engineering, Santa Clara University, Santa Clara, Calif.; phone: (408) 554-2730; fax: (408) 554-5474; e-mail: hit-i@sunrise.scu.edu.

Housing is available on the Stanford University campus in student dormitories. Dorm arrangements ($40/single, $50/double) must be made by August 4 through the Hot Chips conference, not Stanford University. There also are numerous hotels and motels on the peninsula where reservations can be made directly.

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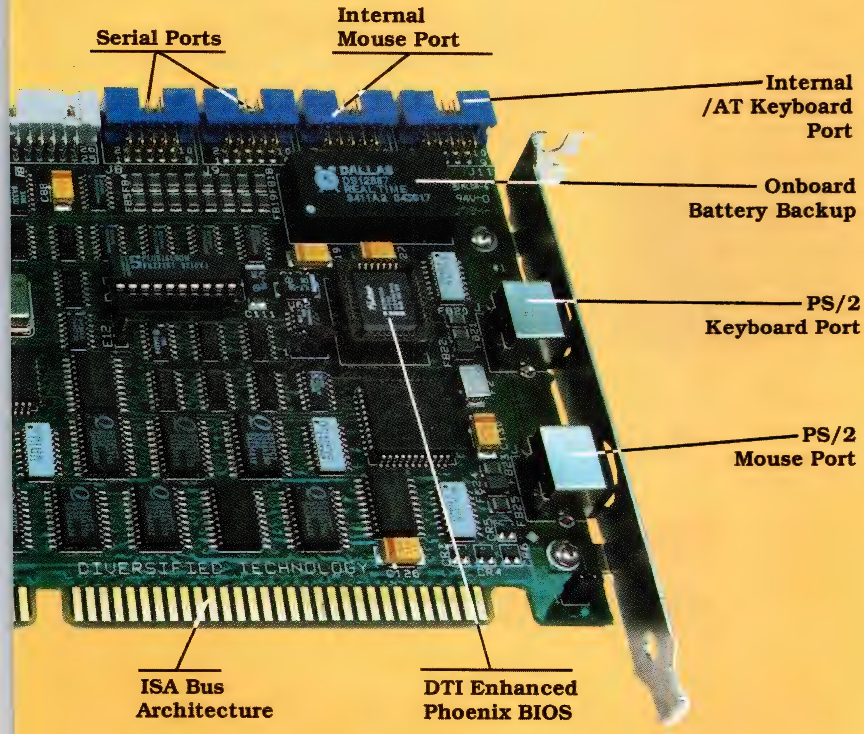

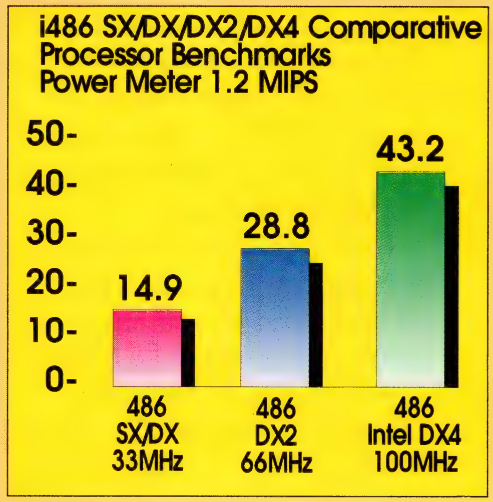

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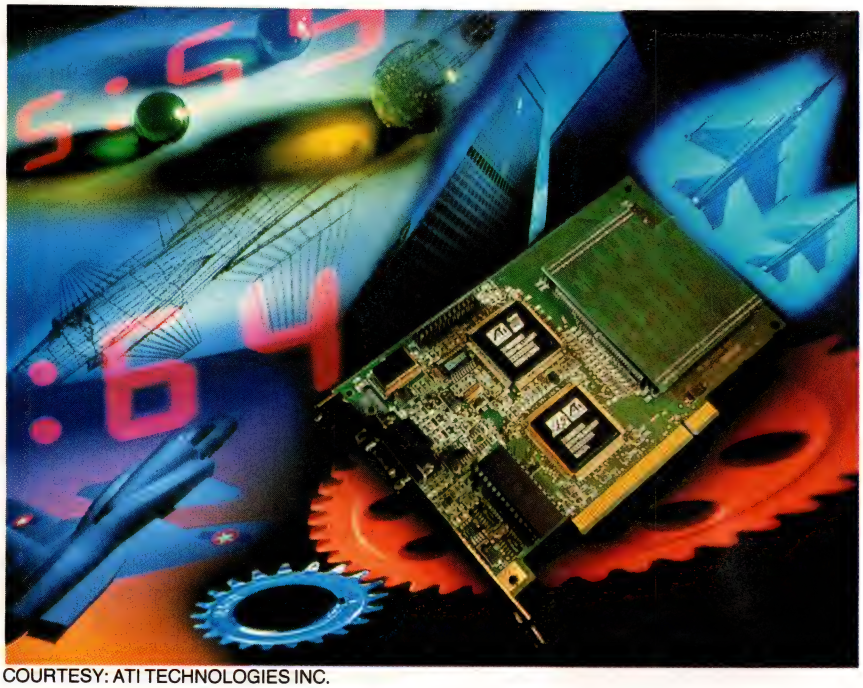

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DEDICATED GRAPHICS SUPPORT CHIPS ACCELERATE OPERATIONS TO IMPROVE DRAWING SPEEDS.

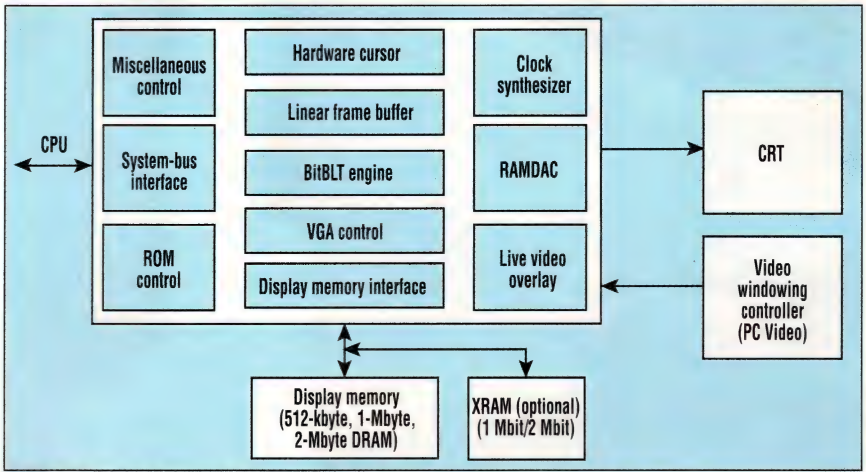
ACCELERATION PUTS THE "SNAP" INTO GRAPHICS

Ever since the first graphics adapters were introduced for the PC or simple frame buffers were used in early workstations, graphics subsystems have been turned on their ear. Today's high-performance graphics cards for PCs employ dedicated acceleration support which contain, in silicon, support logic that speeds up commonly performed operations such as line drawing, bit-block transfers (bitBLTs), cursor movement, color fills, and numerous other drawing functions. The frame-buffer-based graphics subsystems typically found in workstations gain performance as CPU speeds increase. Furthermore, using dedicated drawing and rendering engines in the frame buffers can dramatically accelerate many of the standard 2D and 3D graphics operations.

Two new high-speed local buses—the Video Equipment Standards Association (VESA) local bus or VL-Bus, and the peripheral component interconnect (PCI) bus—are major factors involved the dramatic improvement in PC graphics over the past several years. These buses permit the graphics interface to operate at the clock speed of the CPU bus rather than at the speed of the ISA, EISA, or other traditional expansion buses. That changeover alone has let graphics performance double and quadruple without any other alteration in the graphics subsystem. Because the workstation frame-buffer subsystems already are directly coupled to the main system bus, significant performance gains have already been realized as CPU bus speeds have increased from 20 MHz to 33 and 50 MHz and more.

To compete with the higher-priced Unix workstations for many of the same graphics-intensive applications, PC graphics subsystems have been playing catch-up with workstations. In addition, the use of graphical-user interfaces (GUIs) on the PC requires that graphic subsystems deliver higher throughputs because of the greater amount of data that must be manipulated (pixel movement versus character movement).

Another trend evident in the graphics arena is the move to higher screen resolutions. Over just the last few years, screen resolutions have increased an image's size from the standard 640-by-480-pixel VGA format to 800-by-600-pixel and 1024-by-768-pixel screens. And the desire for still higher resolutions has already resulted in the availability of 1280-by-1024-pixel adapters. Furthermore, adapters for the PC capable of 1600-by-1280-pixel resolution are also making their appearance.



1. BY ADDING AN EXTRA 256-KWORD by 4-bit dram "cache" to this video subsystem, the Wingine 64300 controller from Chips and Technologies can refresh the display from the cache. This eliminates tying up the host CPU for screen refreshing. Together with hardware-acceleration circuitry in the controller, the cache lets the controller deliver a throughput of about 14 million Winmarks.

Early adapters typically had a color range limited to 16 to 256 colors. Today, 256 colors often is considered low end, with 32-k or 64-k 15- and 16-bit colors, referred to as Hi-color, considered mid-range. Today's high-end systems deliver "true color" by using 24-bit color (16-million-plus simultaneous colors). However, delivering all of those pixels at refresh rates of 72 Hz requires that graphics subsystems run at pixel clock rates of more than 100 MHz.

To obtain some of this speed, designers of high-end cards are using dual-ported video RAMs (VRAMs). VRAMs have serial access ports that allow high pixel data rates of typically 20 ns per transfer operation. However, the VRAMs are more complex than DRAMs, have a larger chip area, and typically cost two to three times more than standard DRAMs. With price margins on video cards very small, many video-card suppliers are reluctant to use VRAMs.

But designers at Samsung Inc., San Jose, Calif., think they've found the answer in a dual-ported DRAM known as a "Window" RAM. By focusing heavily on PC-based graphics subsystems, they've come up with a new memory chip that reportedly costs somewhere between a VRAM and a DRAM, yet delivers data-transfer bandwidths of 600 Mbytes/s and higher (ELECTRONIC DESIGN, *Nov. 1, 1993, p. 43).*

For true-color graphics, high pixel clock rates as well as greater memory depths are required. A look at a typical video card and performing a simple calculation quickly shows

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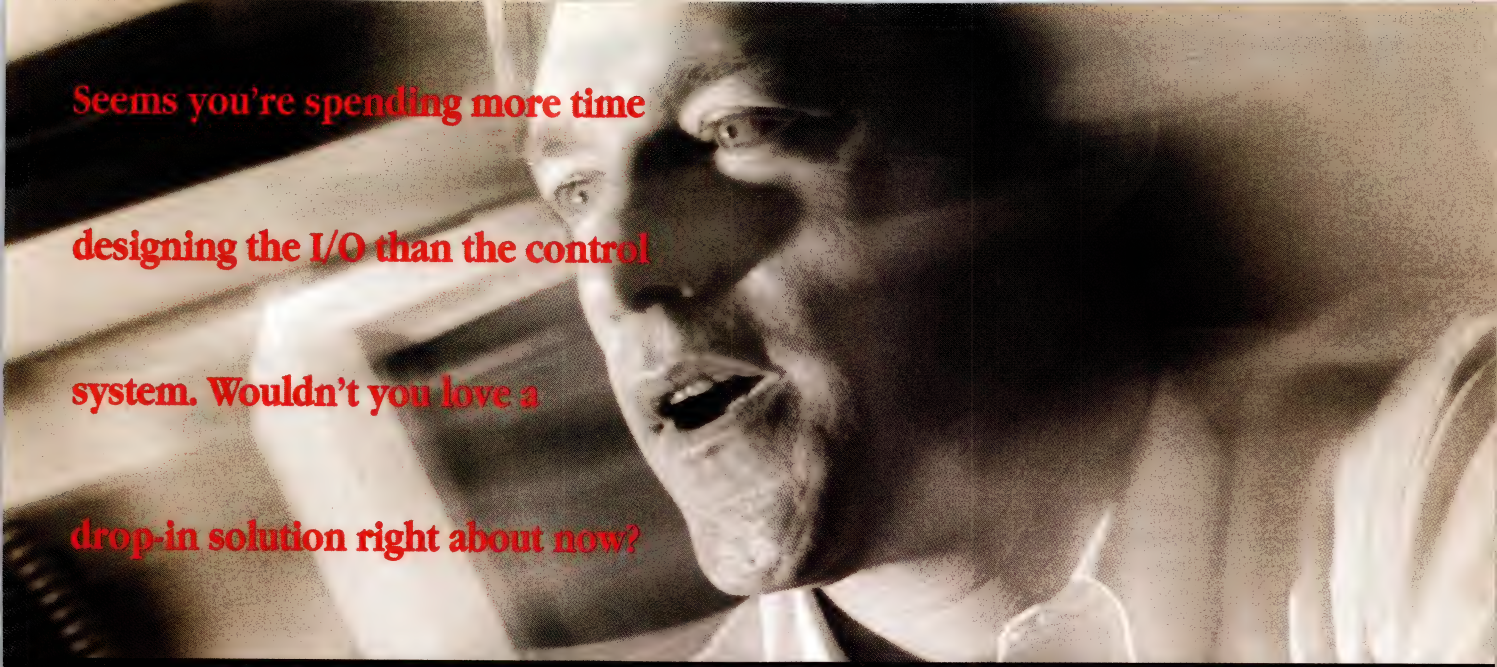

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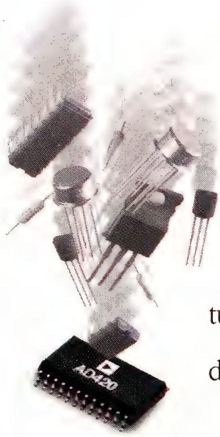

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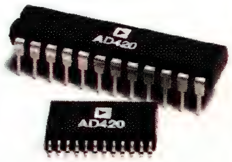

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why. For example, a 1280-by-1024-pixel screen has roughly 1.3 million pixels. To get 24-bit true color, about 30 Mbits are needed per frame. If a non-interlaced display with a 76-Hz refresh rate is employed, about 2 Gbits of display information must be transferred/s. And, a system's drawing speed is directly related to the available graphics bandwidth after the screen is refreshed.

The high data rates are thus forcing designers to redesign the graphics subsystem, widening various data paths (moving from 16- and 32-bit wide paths to 64-bit and even wider data paths), and accelerating various functions. Another element to consider is that graphics subsystems are becoming more integrated—functions such as the RAMDACs, voltage references, and clock generators are being incorporated on the controller. Not only does that save board area and reduce potential electrical radiation, but it allows designers to use very wide on-chip buses to move data quickly between blocks.

Accelerating standard graphics, though, is just the starting point. The latest designs are examining simple approaches to accelerate multimedia-related functions—video decompression, window sizing, etc. Current systems either require a standalone card for image handling, or perform the operations with software running on the host system's CPU. Running the software on the host CPU will limit the multimedia performance unless the CPU includes features specifically to support multimedia. Thus far, only the recently released PA-RISC 7100LC CPU from Hewlett-Packard Co., Fort Collins, Colo., includes specific functions to accelerate multimedia.

Future graphics systems will incorporate extra functions that will directly support imaging operations in accordance with JPEG, MPEG, and Px64 standards. To do that, dedicated support chips or general-purpose digital-signal-processor chips can be used to add the processing horsepower needed for future multimedia applications.

For example, the recently released MVP processor from Texas Instruments Inc., Houston, Texas, provides four 32-bit integer processors and a 32-bit floating-point unit on one chip. The chip's multiprocessor architecture and shared-memory capability suit it well for multimedia applications. Similarly, the large on-chip memory and high computational speeds of the Sharc DSP chip developed by Analog Devices Inc., Norwood, Mass., suits that chip well for multimedia support. In another example, the MWave DSP processor from IBM Corp., Research Triangle Park, N.C., that accelerates both video and audio.

In addition to multimedia and videoconferencing, system manufacturers now are looking to add 3D graphics capability to PCs. However, 3D graphics subsystems are computationally intensive, often requiring high-speed floating-point calculations to perform key operations such as ray tracing and reflection computations. Dedicated and highly-integrated solutions for 3D displays are just starting to appear. For ex-

ARE YOUR GRAPHICS BALANCED?

Graphics accelerators: Where does the value leave off and the hype begin? After plugging in the accelerator card, does it seem no better than the generic VGA card that was just removed? Conversely, if the system CPU was just upgraded to a double-clocked version and Windows displays still don't have the "snap" expected, where should the finger of blame be pointing?

Perhaps the question to examined more closely is: Does the system have a balanced graphics subsystem? In graphics lingo, is the system graphics-bound or CPU-bound? In the first case, the CPU is waiting for the graphics card to do its job, while in the latter case, the graphics card is waiting for the CPU to supply data. When evaluating graphics and graphics subsystems, Richard Silverman, the senior director of graphics marketing at Trident Microsystems, defined some simple rule-of-thumb tests that help determine potential system shortcomings. These three simple "tests" can provide a quick perspective of where bottlenecks may exist:

Test 1: Do Windows screens have "snap"? Do pull-down menus seem to suddenly appear on command or crawl down the screen? Slow pull-downs are usually an indication of a slow CPU (CPU bound). Oddly, however, indications of a slow CPU can be remedied (at least visually) with a graphics accelerator. By offloading the pixel-by-pixel operations required by a standard VGA controller to a higher-level drawing engine, the system can deliver better visual performance (i.e., give the Windows a "snappy" response).

Test 2: What do you do when even with a graphics accelerator, moderately-complex drawings take bothersome amounts of time to redraw? An established rule of thumb says that, to prevent user impatience, no operation should take more than about 0.5 seconds from "go." A graphics accelerator only ensures that each object it receives from the CPU is drawn fast. But, if the CPU can't send the object list that describes the drawing in less than 0.5 seconds, no graphic accelerator can help and a CPU or bus upgrade should be considered.

Test 3: A graphics accelerator appears to be installed but performance is spotty. Windows have snap but applications with lots of lines, area fills, or large image loads seem no better than with a standard VGA card. To qualify as a graphics accelerator, a card should supply a full suite of hardware acceleration functions: line drawing, 256 raster drawing operations, a hardware cursor, and color expansion for text. Some graphics chips don't include all of these key aspects, so they don't truly qualify as accelerators.

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ample, last month 3DLabs unveiled a graphics processor/accelerator that will make possible a generation of low-cost 3D adapters for PCs and RISC-based computers (ELECTRONIC DESIGN, *June 13, p. 158).*

For ultimate performance, PC graphics system designers have taken two approaches. One involves using the VL-Bus or the PCI bus in conjunction with dedicated accelerator chips, providing graphics performance in the 15-20 million Winmark range. In comparison, most standard ISA-bus super-VGA adapters deliver performance in the range of just 1 or 2 million Winmarks *(see "Are your graphics balanced?," p. 58).*

The alternate approach is to partially redesign the PC to give the graphics subsystem more of a frame-buffer-like architecture and take advantage of the horsepower available in the CPU. The only problem with this approach is that the PC's base architecture may have to be modified, a risk few are willing to take. That's because the PC must remain compatible with previous architectures so that it can run all of the existing software. One scheme that somewhat blends the two approaches is the Wingine video-cache architecture developed by Chips and Technologies, which is now employed by several graphics-card makers.

A number of new video architectures also are being proposed, promising much greater memory bandwidths. Thus, they will be able to deliver higher-performance graphics without dramatically increasing graphics subsystem costs or complexity. In fact, some of the schemes, such as the one proposed by Rambus Inc., Mountain View, Calif., using their innovative byte-serial high-speed interface, can dramatically simplify the graphics subsystem. Alternately, designers at various companies are looking at a proposed token-passing bus called RAMlink, which Apple Computer Corp., Cupertino, Calif., had a hand in defining.

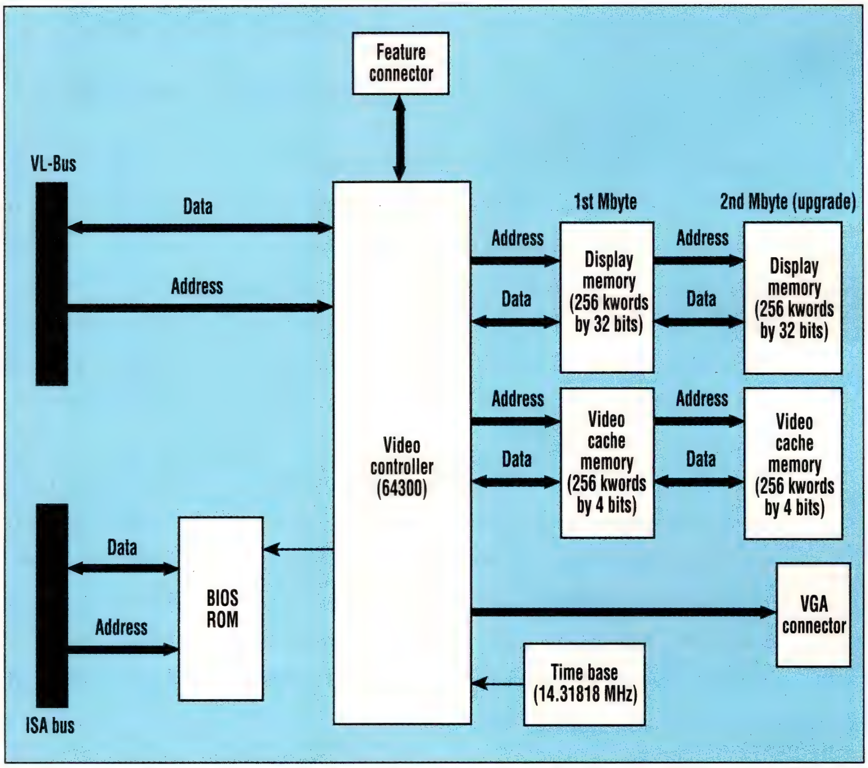
Before looking at some of the architectural approaches and their silicon implementations, it's helpful to examine how various bottlenecks have been eliminated and how other performance bottlenecks were brought to light during that process. As mentioned earlier, the first bottlenecks in older graphics subsystems could be seen in two areas: data-width limitation of expansion-bus interfaces and the slow speed of the pixel clocks.

Expansion-bus interfaces, which in ISA-bus (AT-bus) systems typically ran at only 8 MHz, were limited to 16- or 8-bit data transfers. The slow speed of the pixel clocks was in part limited by the monitor's performance and the amount of data to be displayed. It also was limited by the speed of the VGA controllers employed. The older video controllers, in turn, were typically limited in their data-movement speed by their 8- or 16-bit interfaces to the local video memory. Changing the host-system interface to a 32-bit data path—via either the VL-Bus or the PCI bus—pushed up data-throughput rates by a factor of two to four. Furthermore, widening the video-controller interface to the video memory allowed the graphics speed to increase dramatically over standard VGA cards.

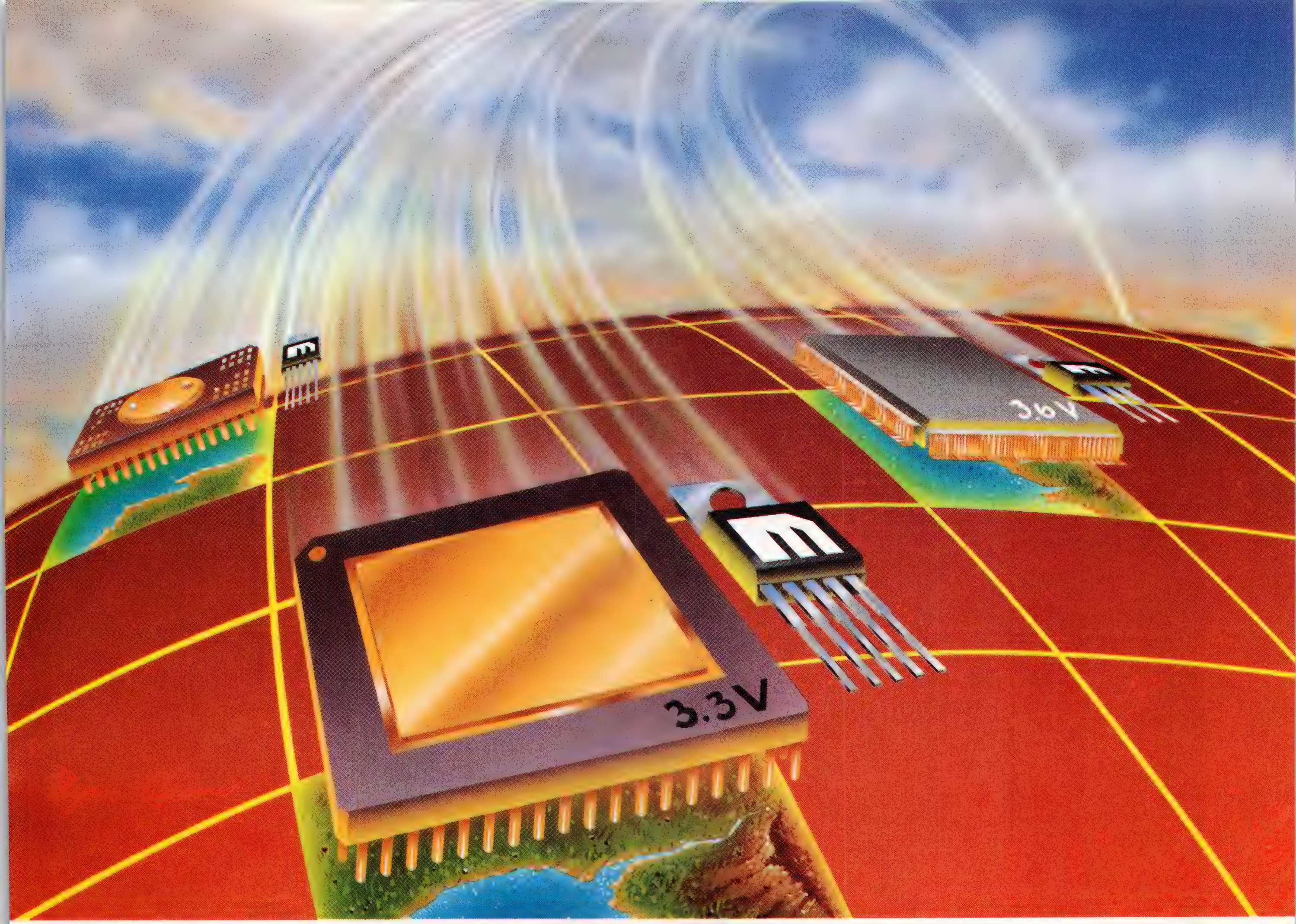
Once those bottlenecks were solved, the next slowdown observed was the drawing speed of the graphics engine, which consisted of the VGA controller and host CPU. GUIs such as Microsoft Windows and many graphics applications perform lots of line drawing, area fills, and block movements. These operations and others can be accelerated with dedicated silicon for drawing engines. Accelerated video-support circuits then were made available from many silicon suppliers—Chips and Technologies, Cirrus Logic, Integrated Information Technology, S3, 3DLabs, Trident Microsystems, Tseng Labs, Weitek, and Western Digital, to name a few. Some board manufacturers (ATI Technologies, Matrox Systems, and others) design their own silicon, and in a few cases, also offer that silicon for other system manufacturers to use.

STARTING THE WARP DRIVE

In addition to accelerating various drawing functions, designers at Chips and Technologies also adopted an architecture that implements a fully addressable linear frame buffer with a twist: an extra memory (a 256-kword by 4-bit DRAM) for each megabyte of frame buffer *(Fig. 1).*



2. PACKING BOTH A RAMDAC AND CLOCK SYNTHESIZER, the highly-integrated Wingine chip makes it possible for companies such as BOCA Research to implement a very simple video adapter card for the VL-Bus.



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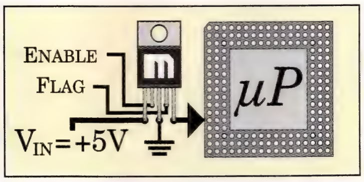

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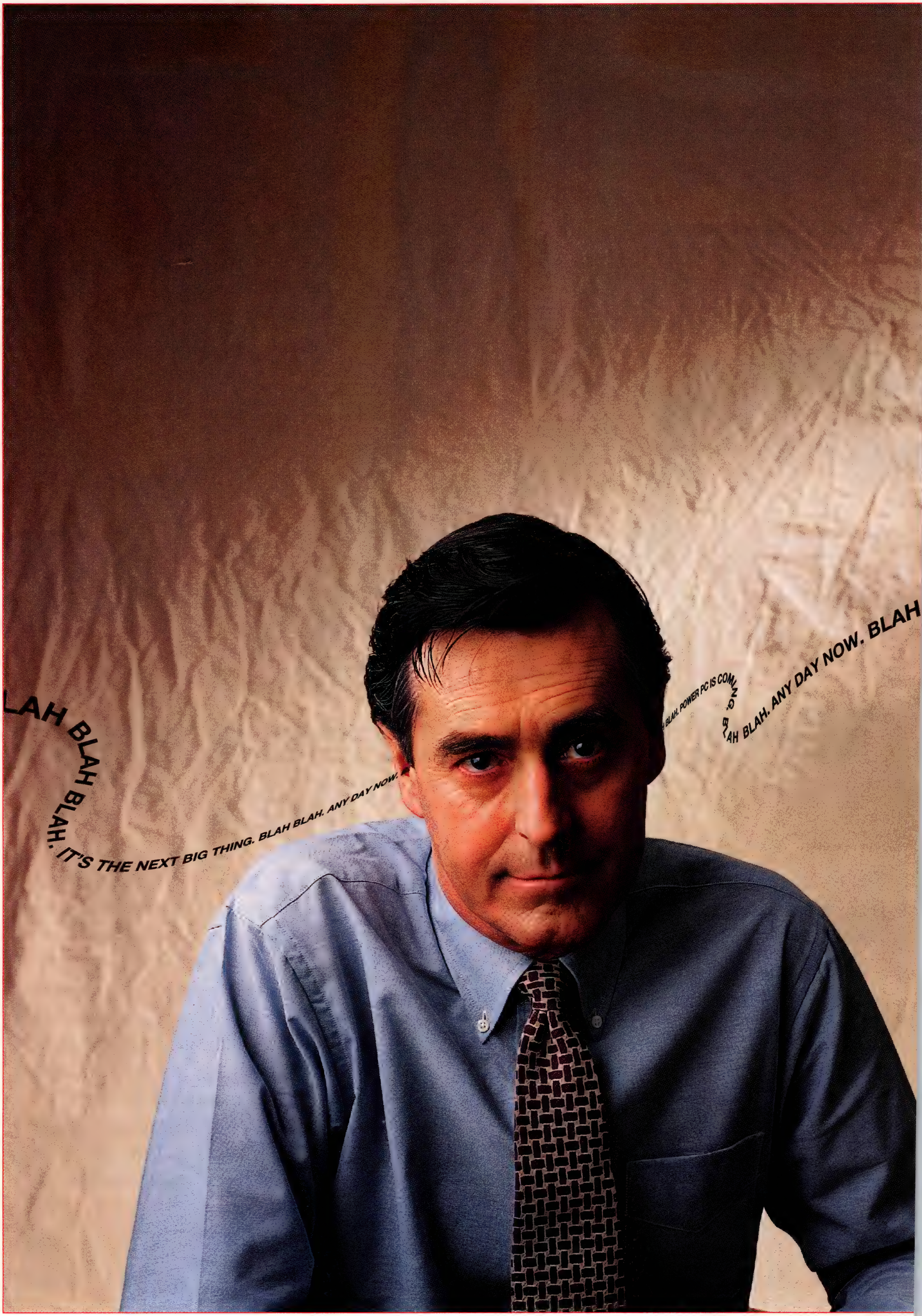
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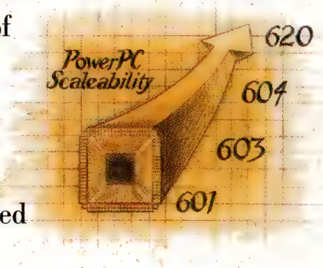

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* Not in native mode.

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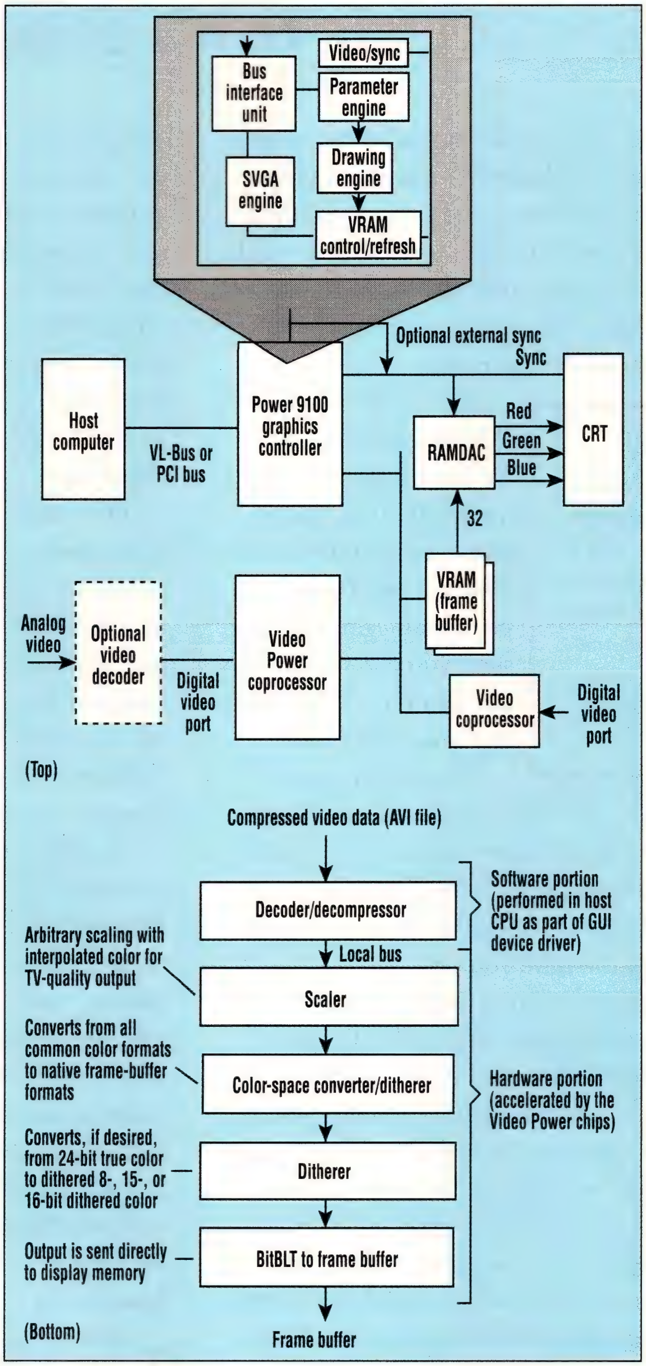
The optional memory, referred to as an XRAM, serves as a video cache that contains the last frame used to refresh the screen.

In a typical system based on the Wingine chip (the 64300 DGX), after the CPU brings in a new frame of data from the video memory, it often must wait each time the screen is refreshed, causing various processing delays. To avoid the delays, the XRAM approach uses the optional video cache to hold the last frame of data. Each time the screen is refreshed, it can use the data in the XRAM for the refresh rather than reading the data out of the main video memory. That leaves the CPU free for other tasks while the screen refresh occurs, improving system efficiency.

The Wingine chip itself provides a 32-bit direct local-bus interface or either a CPU-direct or 16-bit ISA bus interface. It implements all 256 Microsoft raster operations in hardware using a 32-bit bitBLT engine *(see figure 1, again)*. In addition, it includes hardware line drawing and cursor support (64-by-64-by-2), an integrated video overlay interface (16-bit RGB pixel port with internal 24-bit-per-pixel color key), and both front- and back-end FIFO registers for data-rate elasticity.

"Green" system support also is included. The horizontal and vertical sync lines can send signals to the CRT, allowing the CRT system to power down. Moreover, the Wingine's internal RAMDAC can be powered down and the internal clocks slowed or stopped.

To build a system with the chip, designers need only add the video memory (1 or 2 Mbytes of DRAM), the optional XRAM, and a few passive components totaling about $61. The result is a system that can achieve 14 million Winmarks (Winbench 4.0) when run with a 1024-by-768-pixel, 256-color display at 70 Hz on a 486DX2-66 system with 8 Mbytes of DRAM and 256 kbytes of cache. Even though other graphics chips can deliver higher raw performance, the results give the chip one of the best cost-per-Winmark ratings.


Bus interface unit
Video/sync
Parameter engine
Drawing engine
SVGA engine
VRAM control/refresh
Optional external sync
Sync
Host computer
VL-Bus or PCI bus
Power 9100 graphics controller
RAMDAC
Red
Green
Blue
CRT
32
VRAM (frame buffer)
Analog video
Optional video decoder
Digital video port
Video Power coprocessor
Video coprocessor
Digital video port
(Top)
Compressed video data (AVI file)
Decoder/decompressor
Software portion (performed in host CPU as part of GUI device driver)
Local bus
Arbitrary scaling with interpolated color for TV-quality output
Scaler
Converts from all common color formats to native frame-buffer formats
Color-space converter/ditherer
Hardware portion (accelerated by the Video Power chips)
Converts, if desired, from 24-bit true color to dithered 8-, 15-, or 16-bit dithered color
Ditherer
Output is sent directly to display memory
BitBLT to frame buffer
(Bottom)
Frame buffer

3. DESIGNED FOR expandability, the Power 9100 graphics controller developed by Weitek includes a coprocessor interface and a high-performance drawing engine. With a throughput of 30 million Winmarks (Winbench 3.11) on a VL-Bus-based adapter, the chip produces 24-bit color for 1024-by-768-pixel displays (top). When the Video Power coprocessor is added, compressed video data can be expanded with the hardware assist, which performs the scaling, color-space conversion and dithering, and bitBLTs to the frame buffer (bottom).

One company that has implemented the Wingine on a VL-Bus card, BOCA Research, shows just how simple an actual implementation can be. For example, the company's Voyager card merely has the memory blocks as previously described, a BIOS ROM, a time base for the Wingine chip, and several connectors *(Fig. 2)*. The card can deliver resolutions of up to 1280 by 1024 pixels with 256 colors (with 2 Mbytes of DRAM and an 87-Hz interlaced refresh rate), or 1024 by 768 pixels with 65,000 colors, or 640 by 480 pixels with 16 million colors (a 60-Hz non-interlaced refresh rate).

Another approach is to use interleaved-memory techniques. Weitek does just that in its Power 9100 graphics controller with an extendible 64-bit architecture. Designed for the high end of the PC range, the chip delivers fully-accelerated, 24-bit, true color at 25 million Winmarks with screen resolutions as high as 1280 by 1024 pixels, yet uses only 4 Mbytes of video memory (ELECTRONIC DESIGN, *Nov. 11, 1993, p. 155)*. An expansion interface allows coprocessors such as the company's Video Power coprocessor to extend the graphics subsystem capabilities. The Video Power chip adds TV-quality video playback to the graphics subsystem *(Fig. 3, top)*.

The 9100's internal parameter and drawing engines are fully pipelined. Because it has 2D digital filtering capability, the device can perform arbitrary scaling. Used with the Video Power chip, the dual-chip system, when trying to play back a compressed video file, will first decode the file,

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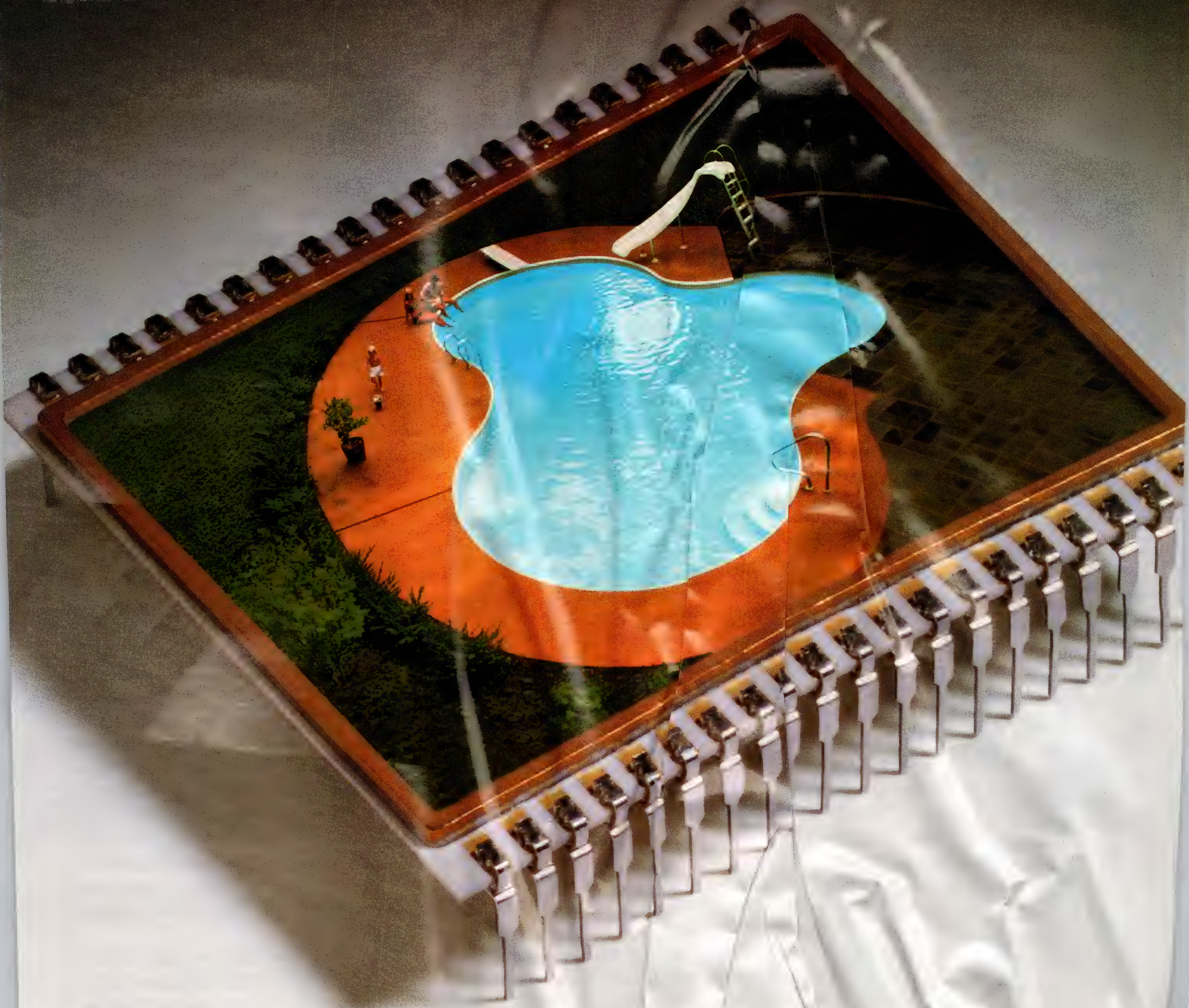

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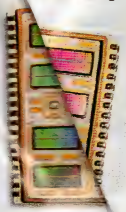

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scale it, perform color-space conversion/dithering, and then prepare the bitBLT pattern to transfer the data to the frame buffer *(Fig. 3, bottom).*

The Power 9100 uses a straightforward shared frame-buffer architecture that allows one frame buffer to support both graphics and video. On the host side, the chip ties directly into either VL or PCI buses, while on the other end it ties into either 32- or 64-bit serial RAMDACs. Support of the packed-pixel mode gives 33% more frame-buffer and RAMDAC bandwidth than standard 32-bit modes, and internal dithering schemes help convert from 24 bits per pixel to 16 or 15 bits per pixel for 8-bit palettes.

The Video Power coprocessor accelerates the computations for video applications by performing all postdecompression processing—interpolative scaling, color-space conversion, and dithering—in hardware rather than on the host CPU. As a result, digital video applications can produce full-screen images at 30 frames/s with resolutions of up to 1280 by 1024 pixels. Quality is maintained, even at high magnification, thanks to arbitrary interpolative scaling. Such scaling has greater accuracy than the more common pixel replication approaches. Without the hardware assist, video windows would be limited to small regions—160 by 120 or 320 by 240 pixels.

The technique of using a coprocessor expansion port also can be seen in the Vision964 accelerator from S3. It provides a 64-bit graphics engine that accelerates various operations, including bitBLT transfers and rectangle fills. The chip's high-speed VRAM frame buffer can sustain data transfers of up to 720 Mbytes/s to the display screen. The circuit also can simultaneously process two 32-bit/pixel (true-color) operations or four 16-bit/pixel (high color), or eight 8-bit/pixel operations per clock cycle. To support multimedia applications, the circuit is able to access a linear video-memory address space, and perform posted writes of CPU data to the video memory. The coprocessor interface allows support circuits to scale video and provide more color depth at greater resolutions.

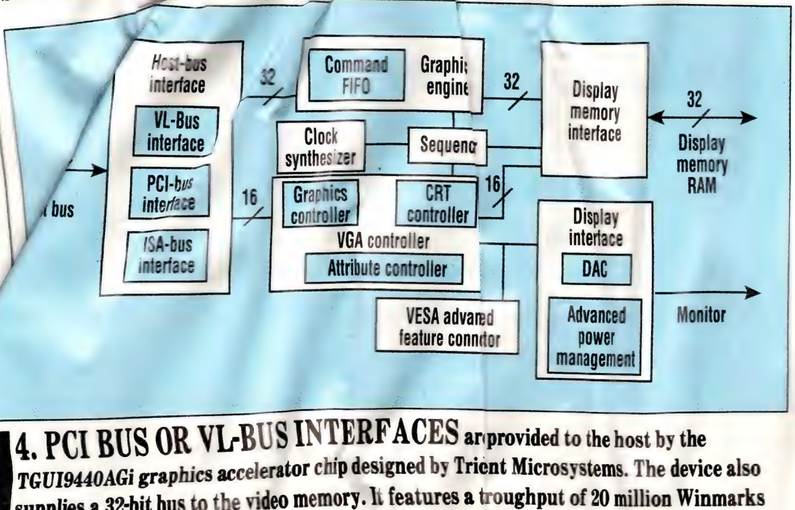
One of the first companies to commit to using the Vision964 is Diamond Computer Systems. Its Stealth 64 implementation delivers a peak throughput of 100 million Winmarks on the older Winbench 3.11 and over 30 million Winmarks on the 4.0 version of Winbench. The card is available in either a VL-Bus or PCI bus format. Additional card manufacturers committing to the chip include ELSA and Miro Computer Products. Miro, of note, has combined two Vision processors on one card for even higher acceleration, and offers that card for high-end CAD and publishing applications.

Intended for lower-cost systems, the DRAM-based Vision864 delivers resolutions of up to 1280 by 1024 pixels with 256 colors or 800 by 600 pixels with 16.7 million colors, both with a non-interlaced 72-Hz refresh. Most recently, both IBM and Digital Equipment Corp. have adopted S3's Vision864 64-bit accelerator. DEC will use the chip on its LPx+ Value Line and DECpcXL Premium line PC-compatible computers, while IBM will use the same chips in its latest ValuePoint family of PCs. The Vision864 can transfer data at rates of up to 240 Mbytes/s into the frame-buffer memory and sustain up to 220 Mbytes/s to the display. Some of the other vendors committing to the S3 chips include Actix Systems, Number Nine Computer, and Vermont Microsystems.

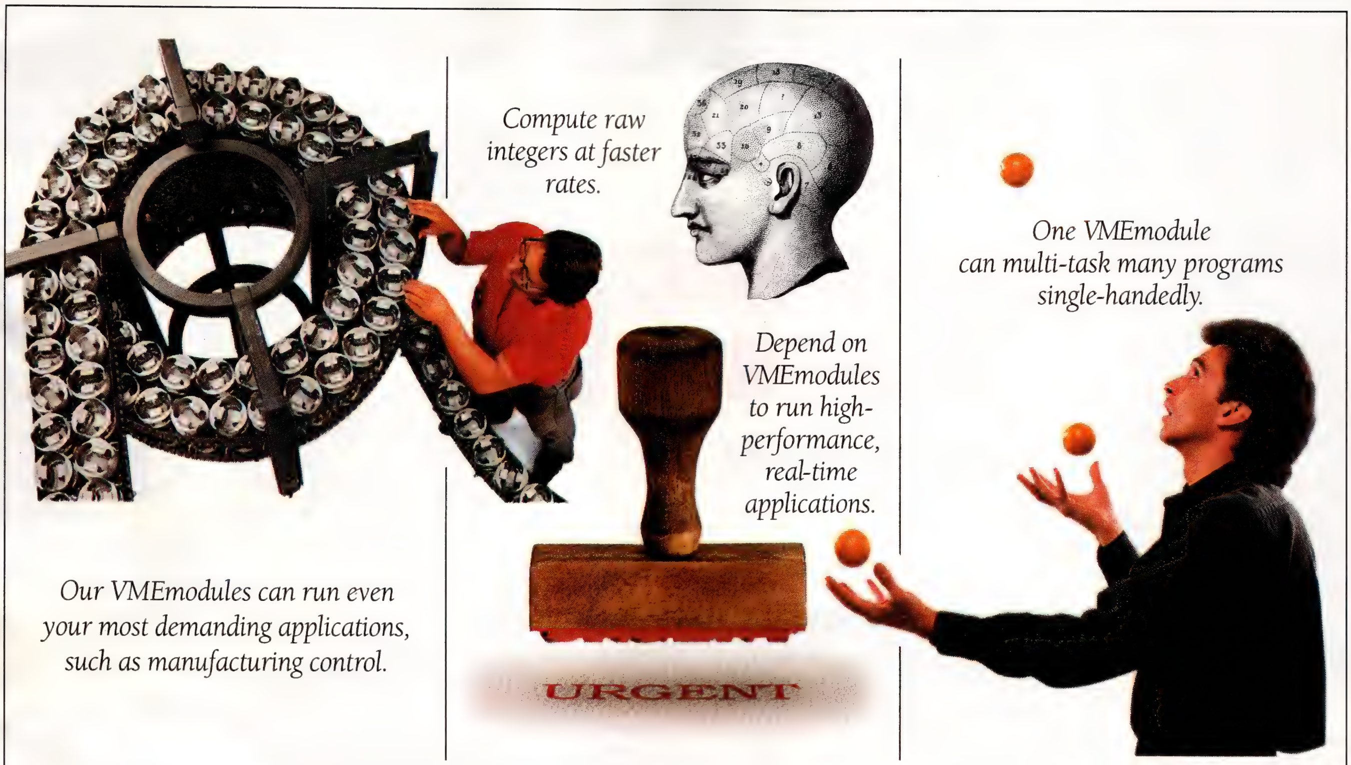
A pair of highly-integrated graphics accelerators, one targeted at low-cost systems and the other at mid-range high-end systems, were just unveiled by Trident Microsystems. These chips supplement the company's previously released TGUI9420DGi accelerator, which has an upper clock frequency of 80 MHz for the on-chip, 24-bit, true-color RAMDAC. Like the 9420, the 9440AGi and forthcoming 9460XGi incorporate PCI bus and VL-Bus interfaces as well as the integrated 24-bit RAMDAC, a dual clock synthesizer, and hardware cursor support for 64-by-64-by-2- or 32-by-32-by-2-pixel images.

However, the 9440 and 9660 allow for higher operating frequencies—108 and 135 MHz, respectively—which permits screen resolution maximums of 1280 by 1024 pixels with 256 colors at 60 Hz non-interlaced, and 800 by 600 pixels with 64 kcolors at 80 Hz non-interlaced. The higher-performance 9660 delivers 1280 by 1024 pixels with 256 colors using a 75-Hz non-interlaced monitor, or 16 million colors on an 800-by-600-pixel screen. With an external RAMDAC, displays of up to 1600 by 1280 pixels with 256 colors can be provided. Estimated benchmark performance of the chips is about 20 and 27 million Winmarks (4.0).

To get the high performance, the chips employ lots of on-chip parallelism to process the image data rapidly. Lying at their heart is an acceleration engine that handles bitBLTs, line drawing, short-stroke vectors,



4. PCI BUS OR VL-BUS INTERFACES are provided to the host by the *TGUI9440AGi* graphics accelerator chip designed by Trident Microsystems. The device also supplies a 32-bit bus to the video memory. It features a throughput of 20 million Winmarks (*Winbench 4.0*), a graphics-acceleration engine, and expansion capabilities via the VESA advanced feature connector port. Also included on the chip is a clock synthesizer, a RAMDAC to drive the display interface, and power-management logic.



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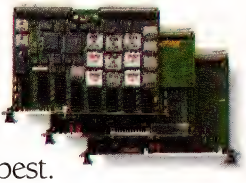

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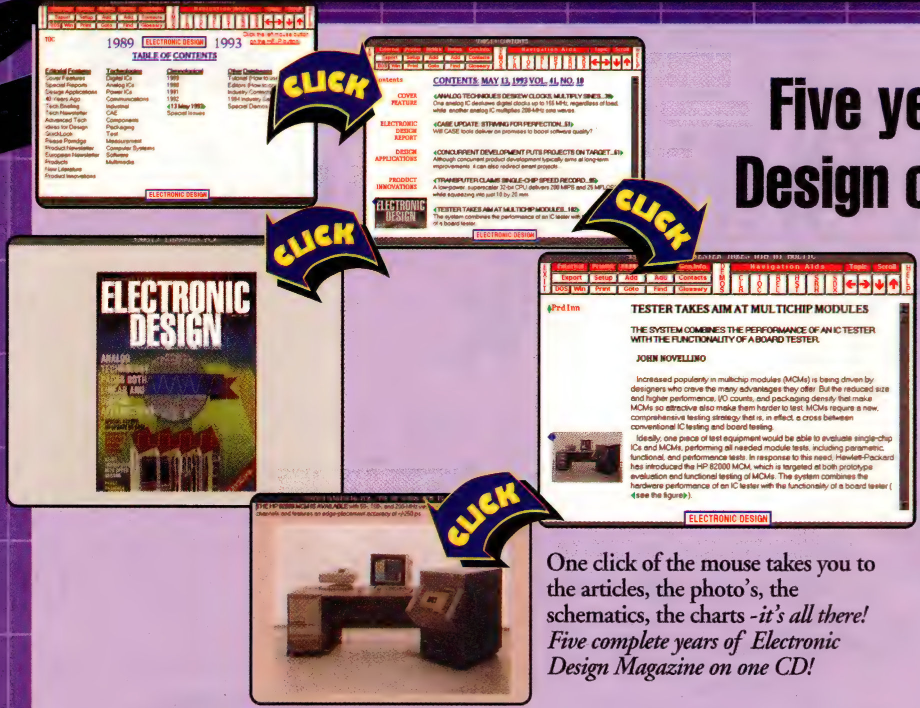

Contents

CONTENTS: MAY 13, 1993 VOL. 41, NO. 10

COVER FEATURE
ANALOG TECHNIQUES DESKEW CLOCKS, MULTIPLY SINES...39
One analog IC deskews digital clocks up to 155 MHz, regardless of load, while another analog IC multiplies 200-MHz sine waves.

ELECTRONIC DESIGN REPORT
CASE UPDATE: STRIVING FOR PERFECTION...51
Will CASE tools deliver on promises to boost software quality?

DESIGN APPLICATIONS
CONCURRENT DEVELOPMENT PUTS PROJECTS ON TARGET...61
Although concurrent product development typically aims at long-term improvements, it can also redirect errant projects.

PRODUCT INNOVATIONS
TRANSPUTER CLAIMS SINGLE-CHIP SPEED RECORD...95
A low-power, superscaler 32-bit CPU delivers 200 MIPS and 25 MFLOPS while squeezing into just 10 by 20 mm.

TESTER TAKES AIM AT MULTICHIP MODULES...182
The system combines the performance of an IC tester with the functionality of a board tester.

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TESTER TAKES AIM AT MULTICHIP MODULES

THE SYSTEM COMBINES THE PERFORMANCE OF AN IC TESTER WITH THE FUNCTIONALITY OF A BOARD TESTER.

JOHN NOVELLINO

Increased popularity in multichip modules (MCMs) is being driven by designers who crave the many advantages they offer. But the reduced size and higher performance, I/O counts, and packaging density that make MCMs so attractive also make them harder to test. MCMs require a new, comprehensive testing strategy that is, in effect, a cross between conventional IC testing and board testing.

Ideally, one piece of test equipment would be able to evaluate single-chip ICs and MCMs, performing all needed module tests, including parametric, functional, and performance tests. In response to this need, Hewlett-Packard has introduced the HP 82000 MCM, which is targeted at both prototype evaluation and functional testing of MCMs. The system combines the hardware performance of an IC tester with the functionality of a board tester (see the figure).

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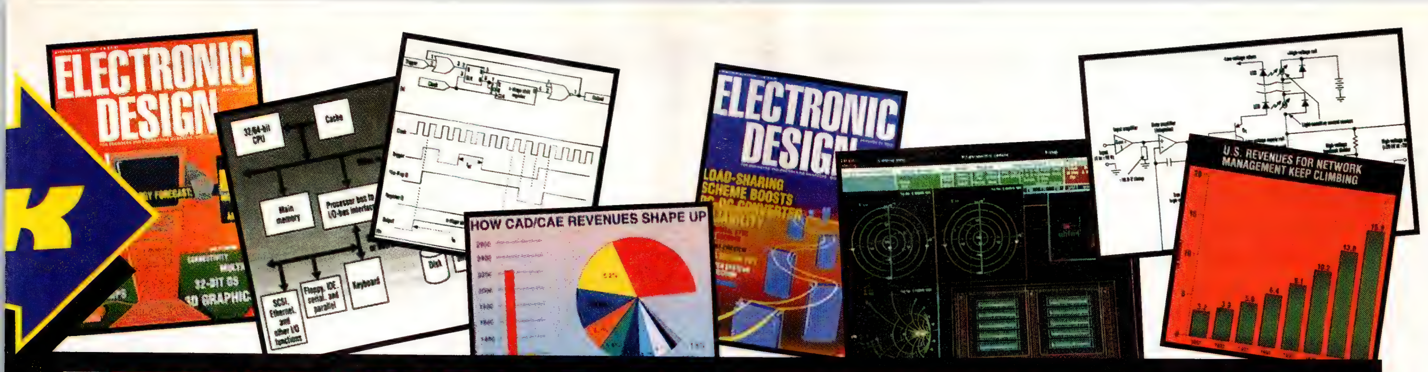
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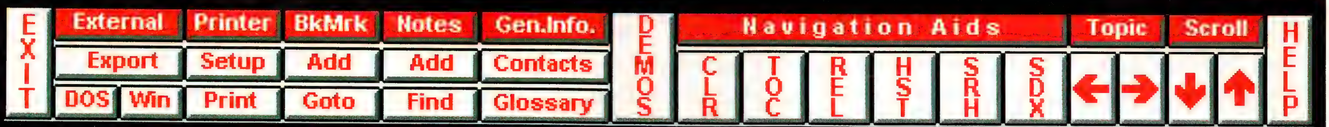

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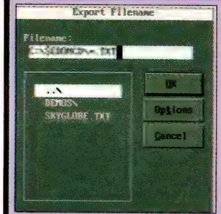

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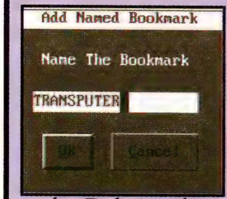

TRANSPUTER

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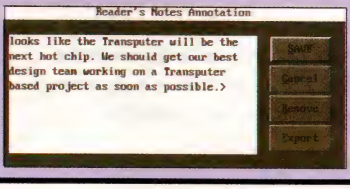

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looks like the Transputer will be the
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Gen. Info - Complete reference

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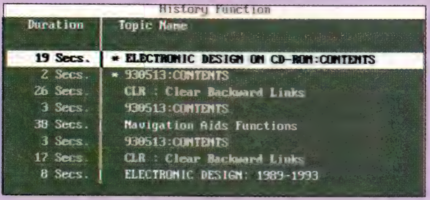

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   2 Secs. | * 930513:CONTENTS
  26 Secs. |   CLR : Clear Backward Links
   3 Secs. |   930513:CONTENTS
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   3 Secs. |   930513:CONTENTS
  17 Secs. |   CLR : Clear Backward Links
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REL - *Show-Related Articles* - Calls up a list of, and lets you move to, related topics.

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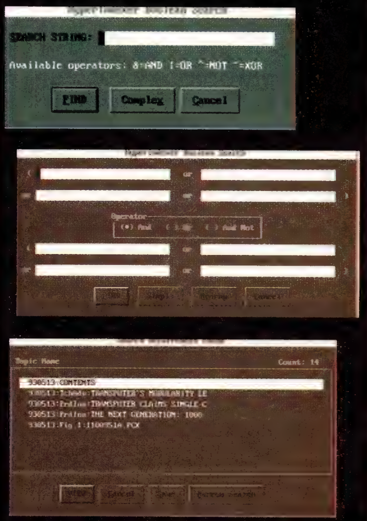

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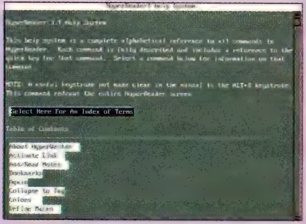


MINIMUM SYSTEM REQUIREMENTS

- ☞ 80386 PC or better
- ☞ VGA video card adaptor w/640 x 480 pixel resolution 16 colors.
- ☞ 1 meg ram
- ☞ MS-DOS Version 3.1 or later

rectangle fills, and text transfers. The engine is fed by very deep FIFO registers for source, destination, and pattern data, which are loaded via a 32-bit-wide bus on the 9440AGi from the display memory, and a 64-bit bus on the 9660XGi *(Fig. 4)*.

Offering high-performance solutions for both the desktop and portable systems, designers at Western Digital came up with the WD33 and WD24A RocketCHIP accelerators, respectively. The WD33, which employs a 32-bit internal architecture, can deliver graphic images of up to 1280-by-1024 pixels with 256 colors or 640-by-480-pixel images with 24-bit color (16 million colors).

The WD24A is probably the only accelerated solution for portable computers. It integrates a 16-bit Hicolor RAMDAC, a programmable dual-frequency clock generator, DRAM and flat-panel control, power management, and a high-performance drawing engine with hardware cursor support.

Flat panels with resolutions of up to 1024-by-768 pixels with 256 colors can be driven by the chip, which has a direct interface for dual-scan color supertwisted nematic displays. To conserve power, the chip operates at 3.3 V and includes improved power management that trims the operating power by more than 30% over previous implementations.

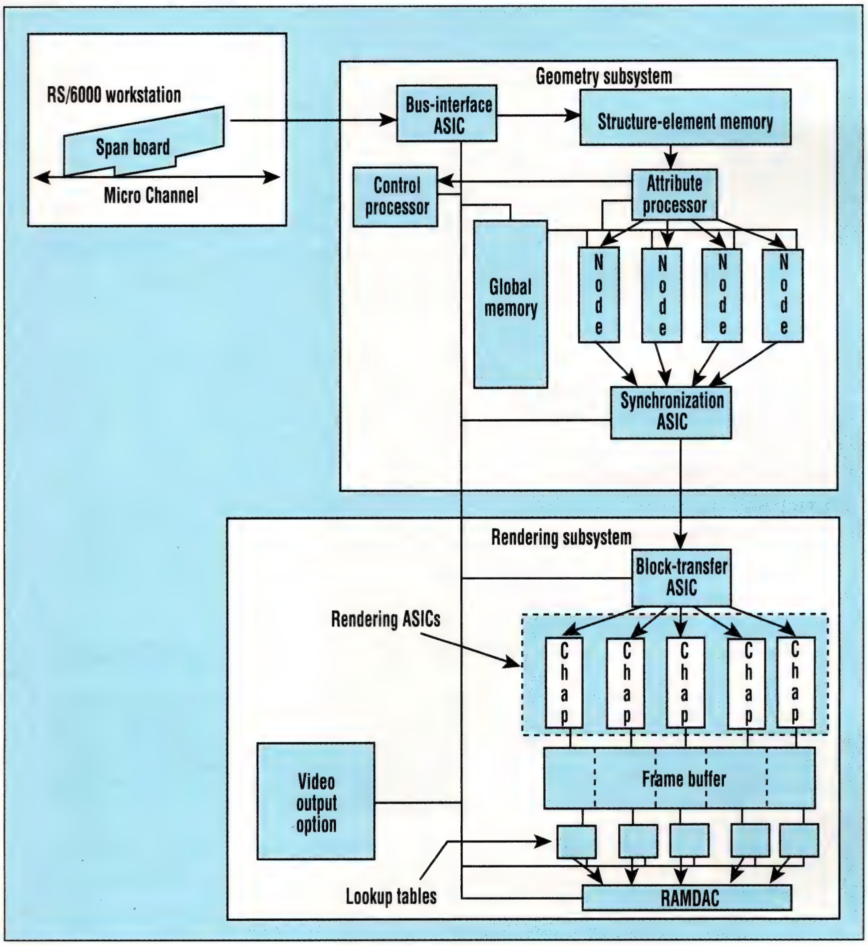
Some companies that sell graphics cards have developed their own graphics accelerator expertise to deliver performance that keeps their products at the leading edge. Matrox, for example, has crafted its own custom GUI accelerator that it employs in its MGA 64-bit card family for Windows, CAD, and multimedia applications. The cards provide video-ready capabilities, hardware-accelerated 24-bit color with a Winbench 4.0 rating of 40 million Winmarks for 1024-by-768-pixel, 8-bit color images and 27 million Winmarks for 800-by-600-pixel, 24-bit true-color images, as well as real-time 3D functions (up to 90,000 Gouraud-shaded, z-buffered triangles/s). The MGA cards can deliver resolutions up to 1600 by 1280 pixels with 16-bit color and 1280 by 1024 pixels with 24-bit color. Refresh rates are up to 200 MHz. The products are upgradable.

Similarly, ATI, another Canadian company, also based its high-performance graphics cards on a custom-developed accelerator chip. The company, however, has decided to open up its graphics systems and now offer its accelerator chips to system developers. The heart of the mach32 and mach64 accelerator cards is formed by custom-crafted chips—the ATI 88800GX and CX. The GX provides a 64-bit memory interface and delivers about 43 million Winmarks (4.0) with a 256-color display. The CX delivers about 15 million Winmarks with an 800-by-600-pixel, 24-bit true-color display.

The mach cards provide much more efficient implementations of many graphics operations. In one case, they use just a couple of instructions to do a bitBLT, versus about 27 CPU instructions on older 8514-type graphics adapters. That greatly improves the controller's ability to handle concurrent operations, thus more is done per cycle.

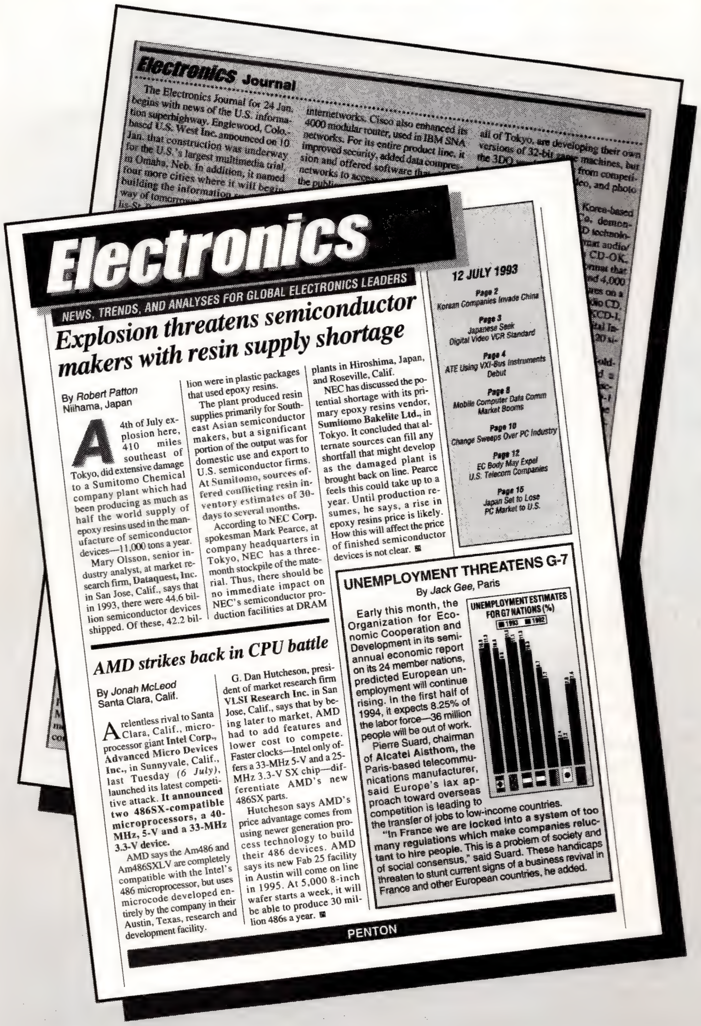
ATI's accelerator chips form the nucleus of its Graphics Pro Turbo and WinTurbo cards, which deliver 16.7 million colors with up to 1280-by-1024-pixel resolution using 100-Hz flicker-free monitors. Part of the boards' performance also is due to a custom-developed RAMDAC, the ATI68860, which operates at the high speeds needed to deliver the true-color displays.

As 2D graphic displays match many of the RISC workstations in



5. HIGH-END GRAPHICS for the RS/6000 workstation family is possible thanks to IBM's GTX1000 Model 002 accelerator. It takes advantage of the high-speed computations of the TMS320C4x family of digital signal processors. Each processing node consists of dual TMS320C42s and is controlled by a TMS320C40 that also serves as the attribute processor. Another TMS320C42 serves as the control processor. Custom chips are used in the rendering subsystem—a bitBLT manager and five Chap rendering circuits. With multiple lookup tables, the graphics subsystem can easily handle overlapping windows without corrupting the window color schemes.

FREE ISSUE OF . . . *Electronics*



The Electronics Journal for 24 Jan. begins with news of the U.S. information superhighway. Englewood, Colo.-based U.S. West Inc. announced on 10 Jan. that construction was underway for the U.S.'s largest multimedia trial, in Omaha, Neb. In addition, it named four more cities where it will begin building the information

internetworks. Cisco also enhanced its 4000 modular router, used in IBM SNA networks. For its entire product line, it improved security, added data compression and offered software that

all of Tokyo, are developing their own versions of 32-bit game machines, but the 3DO

12 JULY 1993

Page 2 *Korean Companies Invade China*

Page 3 *Japanese Seek Digital Video VCR Standard*

Page 4 *ATE Using VXI-Bus Instruments Debut*

Page 8 *Mobile Computer Data Comm Market Booms*

Page 10 *Change Sweeps Over PC Industry*

Page 12 *EC Body May Expel U.S. Telecom Companies*

Page 15 *Japan Set to Lose PC Market to U.S.*

Explosion threatens semiconductor makers with resin supply shortage

By *Robert Patton*
Niihama, Japan

A 4th of July explosion here, 410 miles southeast of Tokyo, did extensive damage to a Sumitomo Chemical company plant which had been producing as much as half the world supply of epoxy resins used in the manufacture of semiconductor devices—11,000 tons a year.

Mary Olsson, senior industry analyst, at market research firm, **Dataquest, Inc.** in San Jose, Calif., says that in 1993, there were 44.6 billion semiconductor devices shipped. Of these, 42.2 billion were in plastic packages that used epoxy resins.

The plant produced resin supplies primarily for Southeast Asian semiconductor makers, but a significant portion of the output was for domestic use and export to U.S. semiconductor firms. At Sumitomo, sources offered conflicting resin inventory estimates of 30-days to several months.

According to **NEC Corp.** spokesman Mark Pearce, at company headquarters in Tokyo, NEC has a three-month stockpile of the material. Thus, there should be no immediate impact on NEC's semiconductor production facilities at DRAM plants in Hiroshima, Japan, and Roseville, Calif.

NEC has discussed the potential shortage with its primary epoxy resins vendor, **Sumitomo Bakelite Ltd.**, in Tokyo. It concluded that alternate sources can fill any shortfall that might develop as the damaged plant is brought back on line. Pearce feels this could take up to a year. Until production resumes, he says, a rise in epoxy resins price is likely. How this will affect the price of finished semiconductor devices is not clear. ■

AMD strikes back in CPU battle

By *Jonah McLeod*
Santa Clara, Calif.

A relentless rival to Santa Clara, Calif., microprocessor giant **Intel Corp., Advanced Micro Devices Inc.**, in Sunnyvale, Calif., last Tuesday *(6 July)*, launched its latest competitive attack. **It announced two 486SX-compatible microprocessors, a 40-MHz, 5-V and a 33-MHz 3.3-V device.**

AMD says the Am486 and Am486SXLV are completely compatible with the Intel's 486 microprocessor, but uses microcode developed entirely by the company in their Austin, Texas, research and development facility.

G. Dan Hutcheson, president of market research firm **VLSI Research Inc.** in San Jose, Calif., says that by being later to market, AMD had to add features and lower cost to compete. Faster clocks—Intel only offers a 33-MHz 5-V and a 25-MHz 3.3-V SX chip—differentiate AMD's new 486SX parts.

Hutcheson says AMD's price advantage comes from using newer generation process technology to build their 486 devices. AMD says its new Fab 25 facility in Austin will come on line in 1995. At 5,000 8-inch wafer starts a week, it will be able to produce 30 million 486s a year. ■

UNEMPLOYMENT THREATENS G-7

By *Jack Gee*, Paris

Early this month, the Organization for Economic Cooperation and Development in its semiannual economic report on its 24 member nations, predicted European unemployment will continue rising. In the first half of 1994, it expects 8.25% of the labor force—36 million people will be out of work.

Pierre Suard, chairman of **Alcatel Alsthom**, the Paris-based telecommunications manufacturer, said Europe's lax approach toward overseas competition is leading to the transfer of jobs to low-income countries.

"In France we are locked into a system of too many regulations which make companies reluctant to hire people. This is a problem of society and of social consensus," said Suard. These handicaps threaten to stunt current signs of a business revival in France and other European countries, he added.

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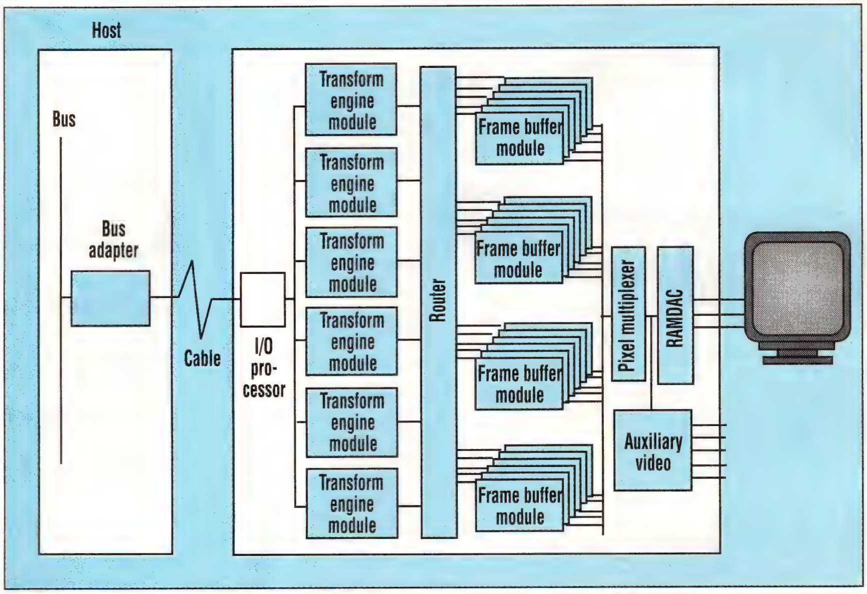
performance, the next step for designers is to add 3D capability to PCs, giving them the full display rendering capability glorified in workstations such as those offered by Silicon Graphics Inc., Mountain View, Calif., and others. One of the first standalone chips for 3D graphics on a PC platform is coming from 3DLabs, a management buyout of Dupont Pixel.



6. ONE OF THE HIGHEST-PERFORMANCE GRAPHICS **accelerators available is the Denali system created by Kubota. It employs a highly parallel architecture that includes six transform engine modules. Each module contains a transform computation engine, several additional custom chips, and fast memory that perform the geometry transformation, lighting and shading, and scan conversion and rasterization of the primitives. The computed results are fed to a data router that sends the image data to up to twenty frame buffer modules. These modules perform the rendering on a per-pixel basis. Up to 2 million 3D vectors/s and up to 1 million 3D shaded triangles/s can be rendered by this graphics subsystem.**

Unveiled last month, the Glint 3D graphics accelerator provides about 2.5 gigaoperations per second (GOPS) of compute throughput to produce 300-k, shaded, Z-buffered antialiased transparent polygons/s. The Glint, a full subsystem on a chip, comes in two versions: the 300SX and the higher-performance 300TX (has fast texture processing).

The chips each contain about 1 million transistors and implement a high-performance pipeline using a patented block-to-block message-passing architecture. Consequently, the chips deliver 750 kvectors/s (10 pixel lines), move data at 8 Mpixels/s and offer a throughput of 100 million Winmarks with 24-bit true color.

A general-purpose but customizable 3D graphics processor, the SPC1500 developed by S-MOS Systems, offloads many 3D and 2D graphics operations from the host system. With its own on-chip DMA controller for data fetches, an on-chip ROM to hold fixed drawing algorithms, and a RAM-based "cache" to hold software-downloadable custom algorithms, the chip has been optimized for OpenGL and PHIGS+ graphics execution.

The heart of the chip is a microcoded engine and a single-precision floating-point processor that together perform the rendering computations and control operations. The peak performance of the engines yields a throughput of 300,000 triangles/s (gouraud shaded, one-light, triangle strips of 10 triangles each) and 538,000 lines/s for line strips with 10 lines per strip and a color per vertex.

RISC workstations, though, still hold the jewels when it comes to high-speed 2D and 3D graphics. Some of the earliest offerings in the market, workstations from Silicon Graphics, have garnered many awards and kudos for their image-manipulation capability. Much of the performance is due to custom-designed graphics-pipeline processors and a powerful graphics language developed to make image manipulation as easy as possible.

The graphics language has been disseminated to the general market as OpenGL. OpenGL forms the core on which many other 3D graphics subsystems base their processors. The just-described Glint processor, for example, uses the OpenGL 3D application-programming interface, which SGI licensed to Microsoft, Intel, Compaq, and other companies.

Accelerated 3D graphics also are the eye-catching hallmark of the TD-4 and TD-5 Pentium-based workstations released in May by Intergraph. The company developed two OpenGL-compatible graphics accelerators for the systems: a moderate-performance PCI-based two-board set, the GLZ, and a high-performance external "box," the GLI. The GLZ or GLI can deliver images with resolutions of up to 1600 by 1280 pixels, are stereo-ready, and support true-color, double-buffered graphics at all display resolutions.

Both 3D subsystems are based on a common architecture that employs up to 17 custom chips (five different types, some used multiple times). The subsystems achieve their performance by performing the rendering portions of the graphic pipeline—slope calculations, span generation, and pixel interpolation—in dedicated hardware. Floating-point-intensive portions of the graphics computations, such as in transformations and lighting, are executed on the host (dual 90-MHz Pentium CPUs).

The five chips in the system include a bus I/O and DMA FIFO, a graphics engine, a resolver circuit that performs the read-modify-write operations on the Z-buffer, a memory mapper that contains multiple color palettes, and a texture processor. To deliver the high-resolution graphics, the interface to the monitors operates with refresh rates ranging from 76 Hz for the 1600-by-1280-pixel images with 16.7 million colors, up to 186 Hz for resolutions down to 640 by 480 pixels with 16.7 million colors.

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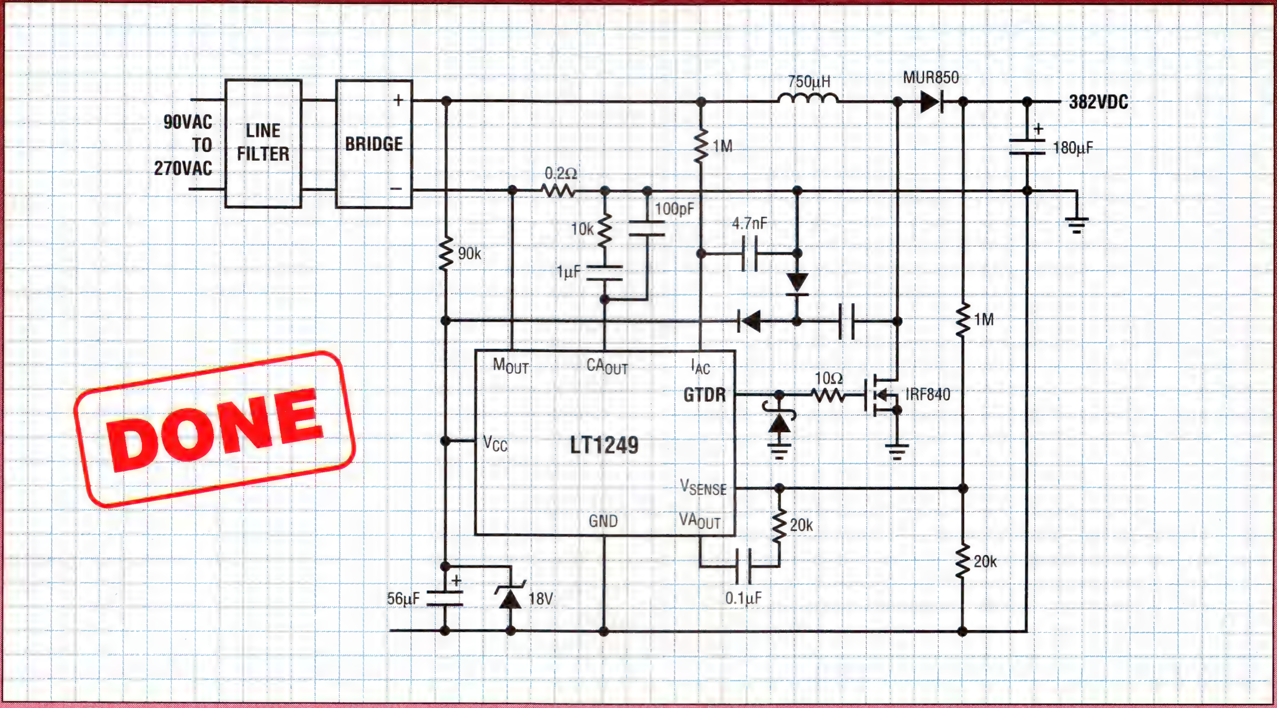

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designers incorporated eight color lookup tables into the graphics chips, thus providing independent color palettes and instantaneous color refinement in demanding imaging applications. In addition, 10-bit gamma correction is available for users to control gamma values with no loss of color resolution.

Although the GLZ will handle texture mapping through software, the higher-end GLI subsystem uses some of the additional custom chips to accelerate the mapping. Texture processing also is fully supported in the GLI with 8 megatextels of texture memory, for full tri-linear interpolation of mip-mapped images.

Thanks to the acceleration, graphics operations common to both the GLZ and GLI can deliver throughputs of 1150-k 3D vectors/s (10-pixel, random orientation, z-buffered); 450-k 3D triangles/s (50 pixel, Gouraud-shaded); 1450 2D vectors/s (10 pixel, random orientation); 26-million-pixel/s bitBLTs (screen to screen, 64-bit R,G,B,A, Z); 400 Mpixels/s for fills, and 240 kcharacters/s of text (9 by 13 pixel font).

Top-performing graphics is the claim IBM is making for its latest additions to the RS/6000 family. System designers created a high-performance 2D graphics subsystem based on a 32-bit-wide data path to VRAM, as well as a top-performing 3D graphics subsystem. The 2D subsystem is based on a custom 2D rendering engine—the pixel accelerator for X (PAX)—and a high-performance palette DAC (the RGB 520). The PAX chip forms the heart of the GXT100 and 150M, Micro Channel-compatible cards that deliver 1024 by 768, 1152 by 900, or 1280 by 1024 pixels.

The PAX engine contains subsections that perform accelerated line draws, area fills, and bitBLTs. The 64-bit, host-system data path attaches directly to the PowerPC CPU bus and buffers all incoming commands until the command dispatch unit sends them off to the area-fill processing unit, the bitBLT engine, or some other subsection. The architecture can support up to 5 Mbytes of frame-buffer memory, up to 256 simultaneous colors, and two different programming models. Using X-windows benchmarks, the GXT150M delivers 3.5 million lines/s (10 pixel lines) and an 11.45 Xmark93 rating.

The PAX chip supports both a direct frame-buffer access mode, and another that responds to Poly (poly referring to the ability to render multiple primitives of the same type with only one command) rendering commands. The direct frame-buffer approach is well suited for applications such as X terminals, while the Poly scheme provides a higher-level programming model that's significantly faster for accelerated functions than the direct frame-buffer access scheme.

For 3D graphics, designers at IBM created several adapter cards and attachment boxes—the Power GTX1000 models 001 and 002 are top-of-the-line external graphics subsystems that provide 1280-by-1024-pixel displays. The subsystems employ a 24-bit Z buffer, provide 32-bit texture mapping, and deliver true-color images. The subsystem ties into the Power workstations via a Micro Channel Span board that provides 32- or 64-bit data streaming at 40 or 80 Mbytes/s over a distance of about 2 meters, or 32-bit programmed I/O *(Fig. 5)*.

The highest-performance version of the drawing subsystem, the GXT1000, model 002, delivers a throughput of 2 million 10-pixel vectors/s in 2D and using OpenGL benchmark can deliver a normalized maximum of 33.6 lit shaded independent polygons. The lower-performance GXT1000, model 001, delivers only 1.54 million 10-pixel vectors/s, and 11.9 shaded polygons on the same benchmark tests.

To do the rendering, the GXT1000 architecture starts with the Micro Channel interface and then passes data on to the various floating-point computational nodes. A control processor (a TMS320C42 digital signal processor) coordinates the entire activity of the accelerator, one of the key blocks of which is the attribute processor, which manages all of the non-rendered instructions (a TMS320C40). Four geometry modes are in the model 002, each of which consists of a pair of TMS320C42 floating-point DSP chips.

Similar high-end graphics subsystems are implemented by Sun, Hewlett-Packard, and many suppliers of workstation add-in cards. However, these still don't represent the ultimate in graphics performance. Other companies (Evans & Southerland and Kubota, for instance) deliver graphics subsystems used for the toughest scientific modeling and 3D rendering applications. The Freedom series 6000 developed by E&S and now sold through IBM includes full X-Window support, and 24-bit multibuffered frame buffers for 16.7 million color displays with antialiased dots, lines, and polygons.

With 2 million 3D vectors/s and 1 million smooth-shaded triangles/s, the Denali imaging and 3D graphics subsystem from Kubota delivers top performance for its Alpha-based graphics workstations. The Denali subsystem actually comes in three performance grades, with the V series offering the highest throughput. The P and E series units deliver about half and one-quarter the throughput of the V series units.

Powering the compute engine are eight proprietary chips that form the graphics pipeline and off-the-shelf floating-point engines to perform key 3D computations *(Fig. 6)*. After data is sent to the rendering subsystem, it's fed into an array of transform engine modules (from one to six, depending on the model). Each module includes a programmable transform engine, several custom chips, and fast memory. The modules perform the first stages of the rendering pipeline—geometry transformation, lighting and shading, and scan conversion and rasterization of the primitives.

The transform modules deliver a stream of pixel packets that are sent to 5, 10, or 20 frame-buffer modules. These modules perform the rendering computations that are applied on a per-pixel basis. Between the frame buffers and the transform modules lies an active router, which ensures that the packet streams from the multiple transform modules are assembled in the right order.☐

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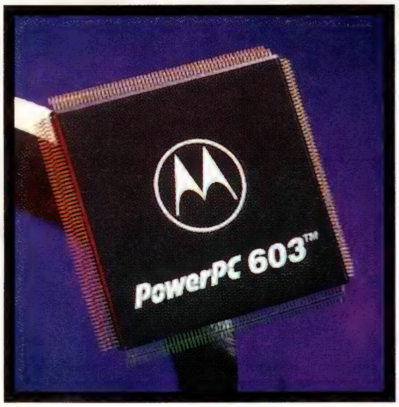

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DESIGN REUSE ACCELERATES BOARD CREATION

BY STRUCTURING BOARD DESIGNS INTO FUNCTIONAL BLOCKS, THOSE BLOCKS CAN BE REUSED IN SUBSEQUENT BOARDS, THUS REDUCING DESIGN TIME.

DICK GOMEZ
OrCAD Corp., 9300 SW Nimbus Ave.,
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Bringing hardware to market quickly in this age of six-to-nine-month design cycles demands that designers concentrate on adding value to a system and reuse as much as is practical to minimize overall development time. These burdensome demands have turned the concept of design reuse into a practical capability, and is now becoming part of the basic design approach rather than an afterthought.

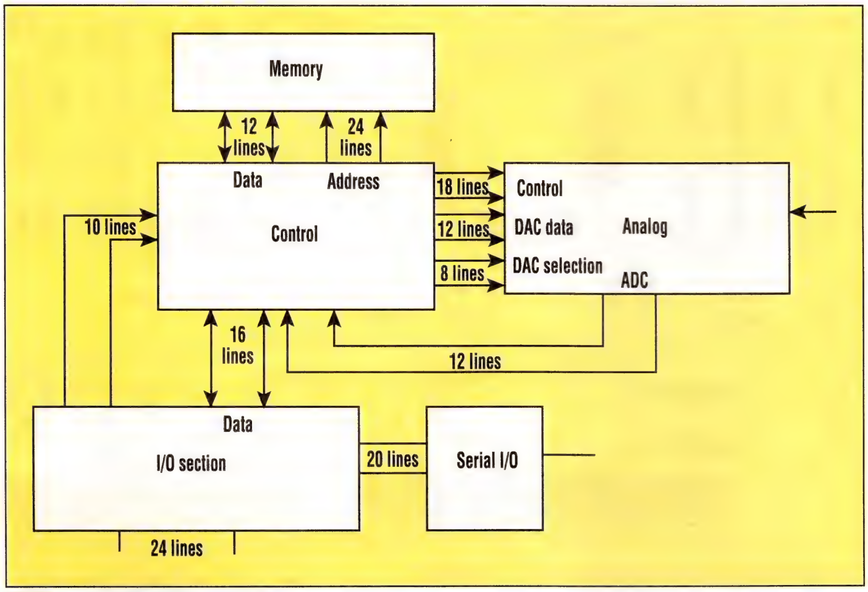
To implement a design structure that can build on the base of existing design techniques and design implementations, PC- or workstation-hosted design tools and libraries of new building blocks form a solid, traditional, starting point that can improve product quality and functionality. Designers typically can use proven circuit techniques and implementations to develop the next iteration of a product family. However, in real-world practices, its rare to see actual sections of a board reused on a wide scale, though reuse at this level would result in great time and cost savings.

Designers often limit their reuse of designs to those concepts and specific circuits that they designed personally. But today's pressures to meet demanding time, cost, and functionality goals are causing engineers to explore every possible way to reduce design time. As a result, design for reuse at the board-hardware level offers one more way for designers to reduce the time and cost of development and to optimize a product's functionality and performance.

Today's packaging and silicon technologies support design for reuse methods exceptionally well. As logic moves increasingly into field-programmable gate arrays (FPGAs) and application-specific ICs (ASICs), with their high-density packaging options, designers can easily take advantage of the wide variety of options to create board modules. This is done by segregating the functions into larger chip-level sections. In addition to this, multichip modules (MCMs) and direct-chip attach techniques will create board sections that have broad reuse potential.

To illustrate one design-for-reuse approach, let's examine the design of a process control board containing multiple channels, which will become part of a family of boards with from 2 to 32 channels. The board design consists of five major sections: memory, control, analog, power, and I/O *(Fig. 1)*. These sections will be designed by five different engineers to achieve some parallelism in the design and help reduce the time to market.

In the design, let's use the following scenario: The analog section will be done by the resident expert; control will be done by an in-house engineer; memory already exists as a board-



1. A CLOSE LOOK at the control block shows the major input and output lines used by the block to tie into the memory, analog, and I/O blocks that surround the control logic.

level module; a contractor will handle the design of the power distribution section; and the I/O will be done by an engineer from the systems group. This engineer will be the project leader and will have overall control of the schematic.

TABLE 1: DESIGN OPTIMIZATION

Element reviewed	Review criteria
Power	Component selection Distribution layout
Analog	Layout constraints Component selection
Control	Which logic technology to use How control and acquisition functions would be carried out
Memory	Size Packaging types to be used for each configuration
All configurations	Number of voltage levels Current for each level

Designing For Reuse

To design something for reuse usually requires a unique approach to design, and in some cases may actually entail a rethinking or re-viewing of the design process so that it's modularized. Once implemented, design for reuse allows a given block—a board module or some other level of subsystem—to be used in another design. At the board level, this means the designer isolates a section of the board so that it can be treated as a module which is usable in new designs as is, or with modifications. Design for reuse, then, allows designers to store their best work, most clever engineering solutions, and tricks of the design trade, so they can be readily accessed and reused as opportunity allows—much in the same way that standard cells from a cell library are reused in a custom chip.

Furthermore, many of the same types of benefits from the custom chip scenario carry over to the board-development environment:

- The design-for-reuse approach allows the designer to use larger functional blocks, thus cutting design time.
- Because the engineer is implementing proven circuitry, debug time also is reduced.
- By eliminating design duplication across projects, the designer can concentrate on new content of the new product, and optimize the new features.
- Design reuse allows the isolation of sections of a product so that each block can be cost reduced.
- Designing for reuse permits design and layout activities to be managed in parallel, cutting product development time.

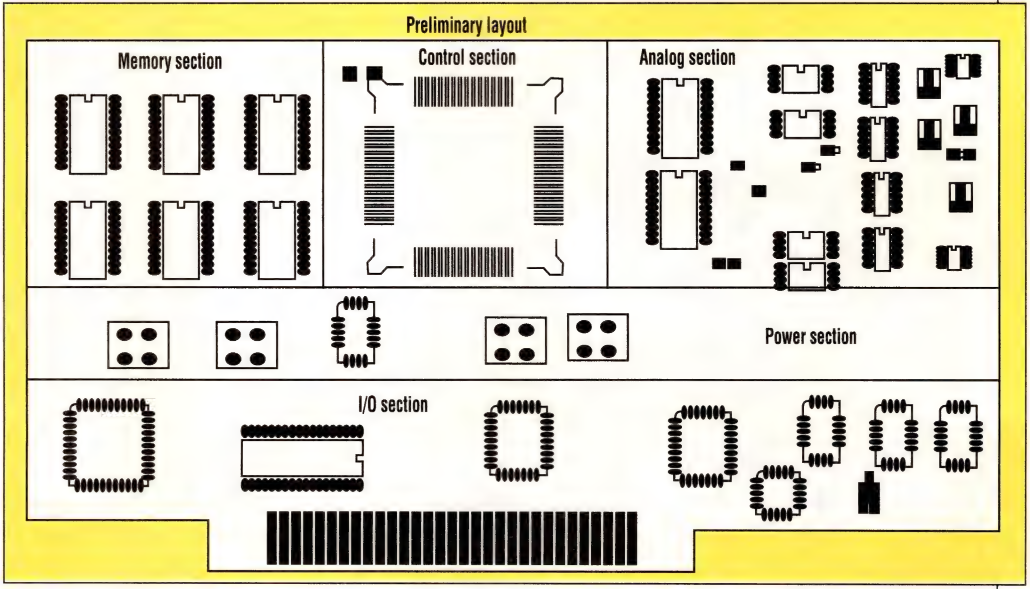
However, design for reuse isn't an all-or-nothing approach. It would be naive to assume that the goal should be 100 percent reuse of a given board section, without modification, in order to call that section a reusable board module. Instead, the goals of design for reuse should be to reduce the time to market, reduce engineering effort and costs, and assure product quality. If reusing only as little as 20 percent of a board section assists in reaching those goals, then such an approach should be considered.

Keep The Design Clear

It's very important to establish criteria for design reuse before analyzing a given design to determine potential benefits of the reuse approach. The following basic criteria should be used to determine whether board sections can be reusable: Is the module isolatable in terms of power and I/O? Is the potential for reuse of the module, or the function performed by the module, high? Is the module, as defined, capable of being readily modified for changes in performance, size, and features?

Design for reuse can succeed only when the design team is organized to support reuse. Sectioning a design into reusable board modules will succeed only if all design team members are aware of the goals and benefits of the design. Consequently, a board module must be defined in terms of its electrical and board functionality. Requirements for package types, space, power, and placement all have to be defined in the context of the total board and in terms of the module and its reuse goals.

For example, if the board were a complex analog and digital design with separate designers working on the different modules, one goal would be to develop the modules to conform to the different designers' sections, and perhaps to still smaller subsections of the overall design. The board layout person also should be involved in the modularization process from the beginning. That helps assure they know how the modules will be defined,



2. BY TURNING A BOARD'S CIRCUITRY into compartments and then making each section a building block, designers can reuse most of their design. Consequently, a considerable amount of design time is saved if they have to design a second board that requires some similar functions.

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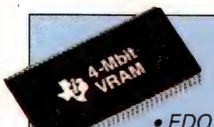

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TABLE 2: FPGA I/O ALLOCATION

Interface	Number of lines
Control to memory	36
Control to analog	38
Control to I/O	26
Control to power	20
Total	122

and lets them have a hand in establishing realistic targets for the space and function isolation.

GETTING STARTED

The first consideration during a board-level design should be to define the functional boundaries and sections of the design. That entails a review of the logical and the physical aspects of the design—in the multiple-channel process control board example, the design team should consider the following items:

- the board space, outline, and connector placements for the different versions of the card family
- the number and type of voltage sources needed on the card
- the ground isolation needed for the analog and digital sections
- the type of logic technology to use
- how the team would approach reusability

Regarding the last item on the list, the team can explore three possible approaches:

1. Design to the maximum configuration, then populate the board as needed.
2. Design segmented sections that can be configured into the full configuration by carrying the full interface needed to join segments together.
3. Optimize the design for each configuration in the family by modifying the basic sections of the board.

Each approach to reusability has particular merits, depending upon the cost, function, and performance goals that the team is trying to achieve, coupled with expected manufacturing volumes for each configuration. In the case evaluated in this article, the design team chose to optimize the design for each configuration (option 3), because the potential sales volume of products for each configuration was sufficient to pay for multiple designs. This is a key point in considering design reusability: Design for reuse can cut the cost of redesign so much that optimized design easily wins out over global design.

The first step in planning the design is to review each section of each board configuration to determine the design changes needed for each optimized board *(Table 1)*. The analog section consists of two current-loop drivers and sensors that detect the status of process-monitoring sensors. This section requires eight digital-to-analog converters (DACs) to provide the bias for the analog section. Furthermore, the analog section requires two analog-to-digital converters (ADCs) to send received information to the local memory, and two set bits that generate an interrupt for over- or underlimit conditions. The section also contains several op amps and discrete components.

PLACEMENT DECISIONS

A review explored whether the DACs and the ADCs should be considered part of the analog section or part of the control section. Consideration was given to performance, I/O definition of the sections, and the potential for future redesign of the sections. If the DACs and the ADCs were placed in the control section, the I/O boundaries between the sections would be reduced to just seven lines. However, if they were placed in the analog section, the I/O interface between the two sections would be 62 lines, with no multiplexing inside of the analog section.

Because the selection and performance of the converters is the responsibility of the analog designer, the decision was made to place them in the analog section, even though this created a larger I/O interface.

Examining the problem of the boundary I/O showed that multiplexing the ADC lines would produce the best overall interface between the analog section and the control section. The trade-off of section-level I/O and decode components for the analog sections was a large concern because of the need to create as small a board outline as possible.

Eight lines were allocated for the multiplex function, and twelve lines were allocated for the DAC and ADC data. In the minimum configuration, the analog section didn't require a multiplexer, but used the eight lines to control the four DACs and the ADC directly. One of the criteria for the analog section was that it be usable as a standalone unit.

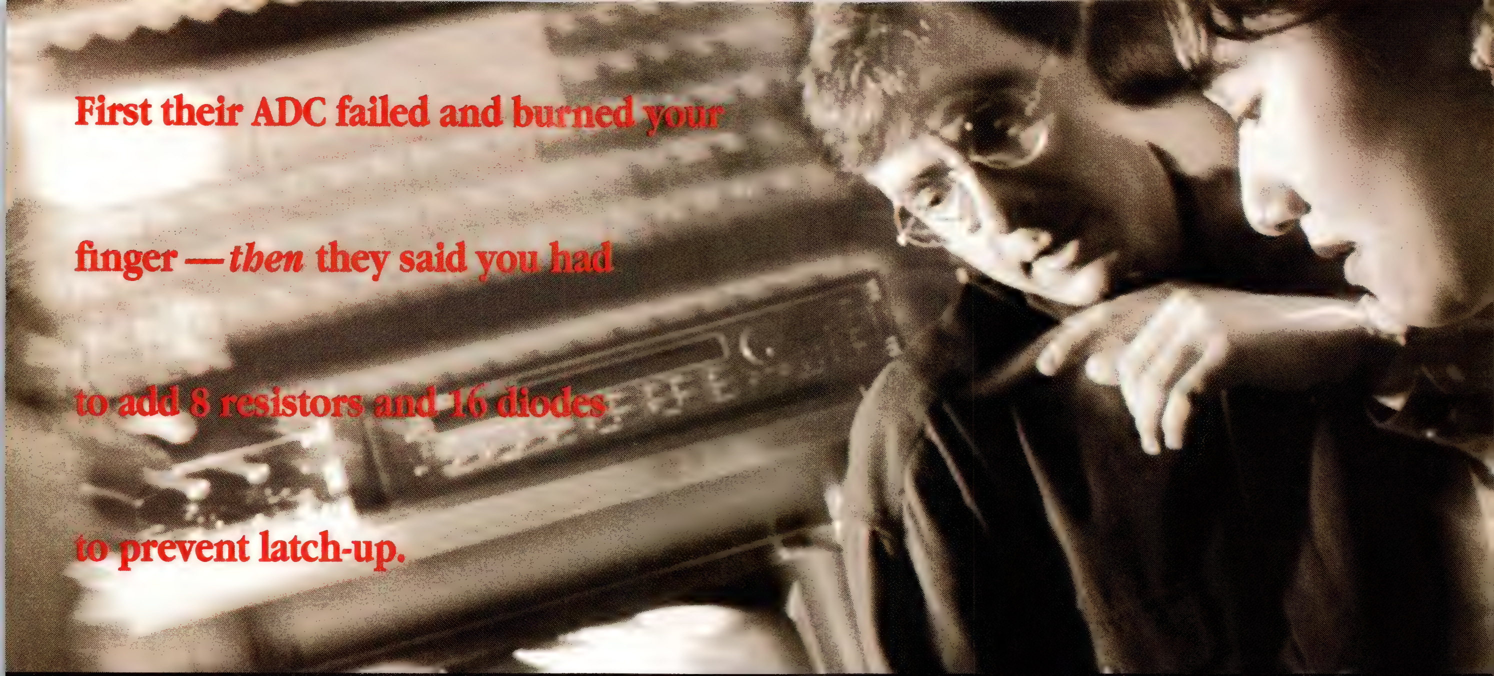
Various evaluations next led to the implementation of the control section in a field-programmable gate array (FPGA). Such a choice also leads to a limitation on the number of lines allocated for DAC control, because the amount of lines would be determined by the FPGA package's pin count. Analyzing how the control section would interface to the other sections also started with the package options allowed by the FPGA circuitry. The allocation of the I/Os used on the FPGA breaks down as listed in Table 2.

Thus, the FPGA requires 122 pins, with 20 assigned to power and ground. A 128-lead plastic, quad-sided flat package is the closest surface-mount option that meets the pin count requirements. Because a few extra pins were available, special DAC select lines were provided for the lowest channel-count configuration so that a decoder wasn't required to select the DACs.

The I/O section was analyzed for the interface to the system and for the interface with other board sections. This section consists of the system connector, the system interface, the long-line driver-receiver chips, and a special telemetry-drive subsection that allowed serial

TABLE 3: CONFIGURATION CHARACTERISTICS

Section	Component count	Placement space	I/O boundaries	Layers
Power	6 regulators 24 resistors 32 capacitors	Board center 5.0 × 1.1 in.	4 inputs 6 outputs	4
Analog	4 dual op amps 12 resistors 8 capacitors 4 dual DACs 10 transistors	Upper right 3.2 × 3.1 in.	20 inputs 12 outputs	4
Control	1 128-pin PQFP 2 24-pin DIPs 5 capacitors	Lower middle 2.4 × 2.5 in.	28 inputs 32 I/O lines 42 outputs	4
Memory	9 32-pin PLCCs 12 capacitors 1 64-pin PLCC	Left side 2.5 × 2.8 in.	24 inputs 12 I/O lines	4
I/O	8 PLCCs	Bottom 8 × 1.7 in.	32 I/O lines 20 outputs	4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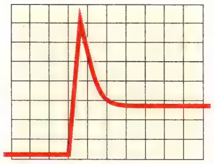

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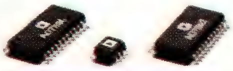

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transmission. The interface to the rest of the system was basically made through the controller chip. The interface between this section and the control section was created with 26 lines, 16 of which are bidirectional.

The next major step in the design process starts with charting the characteristics for each configuration *(Table 3)*. After that's done, the board section shapes can be allocated. Simple diagrams illustrate the different sections and their shapes in board outline form.

The design team then can approach the design by using different supporting schematics for each board section. Such a decision was arrived at for the following reasons:

- The schedule for the different sections showed that the analog section had a shorter design time but longer layout time than the digital section.
- The design-team members wanted maximum freedom in creating their section of the board. The analog designer was going to do his own layout while all other sections would have their layout done by the same layout specialist.
- The lead engineer wanted to coordinate the overall project from a single schematic, allowing him to incorporate the board sections as modules for each of the configurations.
- Because the design consisted of multiple channels, the field support people wanted to have the board sections for the analog and memory sections be designated as channels with the same reference designators used in each channel. This means that a single schematic could be used for the analog section or the memory section, and the field-support people would be able to reference the proper function for each channel of the board.

A rough outline of placement and shape was determined by each member of the team—the shapes initially developed are tentative at this time and can be modified as the design progresses *(Fig. 2)*. This step turned out to be very important, because it allowed the team to see the basic area definitions that worked for each board section, and at the same time allowed them to see the limits of a single-board solution. Each team member now understands the placement and shape of their section.

The board section shapes are assigned by sectioning the total board outline, which then are turned into modules and imported into each board design. This allows the design and layout of each section to proceed independently of the others. Next, the shapes are modified to account for the physical layout. Each engineer can now work on a clearly defined board module that will be used in the different iterations of the product.

The last major step begins with an evaluation of the total time for redesign. A key consideration for design reuse is the amount of redesign time needed to accommodate new features or parameter changes. This means that space, electrical attributes, and layout shapes should be reviewed to determine the range of capability that can reuse all or portions of the design.

For example, in designing the

DESIGN REUSE: A MINDSET FOR THE '90s

Reuse, as a concept, allows designers to automatize virtually everything they do. It encourages them to think of their design experience and expertise as a collection of solutions to design problems, or as "design objects" or "solution objects." The "library" approach develops from this realization. It allows sharing one's work with other team members or future team members. Again this approach emphasizes the need for schematic designers to be able to see and operate on board-section "modules" with a tool that's at least a subset of the final layout tool.

Design for reuse brings about a type of modular thinking in which designs are conceived as sets of modules. In essence, designs yield functions, and in turn yield products. Non-modular thinking, on the other hand, often prohibits reuse because functional blocks are entangled in too much complicated or application-specific circuitry. This prevents sharing. The library approach requires design tools to facilitate developing, storing, accessing, and modifying modules.

When trying to evaluate a board design, there are some easy rules of thumb that can help make the right decision concerning reusing a portion of the system design:

1. Try to reuse power supplies or power-regulating sections because these often are designed by specialists. Debugged circuits are particularly valuable in the power domain. Reuse allows fairly easy modification.
2. Try to reuse I/O interfaces as well, especially when it comes to the connectors and bus interfaces used. The key question here is: What's the best way to put information on this board, and then to take it off?
3. Memory sections also can be reused effectively
4. Reuse is generally ineffective in very narrow, application-specific uses—e.g., a state machine running a specific piece of mechanical equipment (such as a sequencing pump)

And, last but not least, editing, archiving, and the placement of complex, interconnected objects must be an integral part of any reuse toolset. Ready modification is an essential capability. Tools must allow editing of any object at any time. Schematic designers need an affordable subset of a layout tool that allows them to see and edit reusable board sections in the physical domain. This makes it possible to integrate their new design with existing board sections and clearly understand the fit of tier section into the final board.

Tools also must be able to define zones of the board and to modify definitions for different phases of layout. Objects must be totally free to move about. Designers have to be able to add or delete tracks and layers, and to rotate objects. Furthermore, reuse tools should allow for the autorouting of individual modules separately, and then their connection. Finally, the most effective tools should provide a means of "linking" and managing the development efforts of the individual board modules.

power section, component size and spacing will be similar up to a certain power dissipation, but may become significantly different after that. This means that the reusable section would have to be specified as applying to a range of capability wherever possible. Therefore, when the design is archived, its potential for reuse is clearly defined. In general, if reusing a design can save at least 10 percent of the design time and meet cost and functional objectives, reusability is well worth the effort of archiving reusable design modules.

USE THE RIGHT TOOLS

The tools for design reusability must support the concept of isolating sections of a board for use as modules. The editing, archiving, and placement of these board modules must be an integral part of the tools employed by the design team. In this example, the tools have to support the design of board sections that would be stored and treated as modules. Furthermore, the tools must be able to edit module objects, thus allowing changes to be made to accommodate the physical space requirements.

Modifying the individual sections also is an important requirement because the test and debug cycle required that changes be incorporated into the board as soon as possible for short turnaround. Because the team designed the board using different schematics, attention had to be given to forming all of the schematics into a single document, and the tools had to support the ability to combine separate schematics. Then, a hierarchical schematic can show the interconnection of the different board-section schematics. These were brought together as one integrated schematic by placing the appropriate off-sheet module ports in each schematic.

The control section logic was all done within the FPGA. Because it was important to have continuity from the internal logic to the board-level pinout of the FPGA, the team used the same schematic package along with a PLD tool. This section of the board was simulated with a digital simulator; the analog section was simulated with a Spice circuit simulator.

As a result, the board designer could create a schematic that treated the individual board sections as hardware modules. This is one of the biggest plusses for reusability—it allows modules to be clearly defined as near to the end product as possible.

After creating the first rough placement for the dual-channel case, the design team applied the board sections to create the other configurations. It became apparent that the optimum layout for the additional analog and memory sections would be different for any configuration above the dual-channel configuration if they were to achieve optimum board space. The team then adjusted the placement of the basic sections, such as power, ground, and control, to minimize the layout changes for the analog and digital sections as the number of channels increased.

Additional adjustments were made to the basic section allocations and shapes for the minimum dual-channel configuration. The changes allow for the use of a layout that permits the memory and analog sections to be duplicated in all configurations. The power-ground distribution was made through split power and ground planes. Because power and ground didn't have to be routed, the design team had more layout and routing freedom for the other design sections.

Another important design consideration was to place no autoroute boundaries around the analog and memory sections of the board, so that an autorouter could be used to interconnect the different board sections without creating undesirable routes inside these sections. This meant that pads would have to be placed outside the no-autoroute zone and connected to the interior of the board section. This is a basic consideration for all future design-for-reuse efforts.

REVIEW TO MINIMIZE ERRORS

The completed design now allows the team to directly reuse major sections of the board for different configurations. In this particular case, the analog and memory modules could be reused directly with very little modification. The control and I/O sections were basically used intact. The power section required component changes but maintained the same relative component placement. The analog, memory, and I/O sections were reused in totally different designs with very little modification. Subsections of the power section were employed in a number of different designs.

One of the benefits of creating reusable board-section modules was that other engineers feel more confident in using critical blocks, such as the analog section. Because this section's performance was very layout-dependent, the engineers not involved with the analog portion of the design felt much more confident in using the board-section module than if they had to use schematic-level design information only. In addition, the team leader can take good advantage of the ability to isolate the sections of the board, which makes it possible to independently review each section's progress and easily see how each section would go together.

The individual engineers felt that this approach gave them more design freedom and control of their section of the board, and they liked the promise that they could reuse board sections in the future. The layout tool could link different board sections by using a high-level schematic.

The ability to edit modules and interactively assign nets in the board editor was necessary in making this approach viable when reusing sections of the board. The toolset used by the design team had this ability. It facilitated the overall design and release process for the various boards by allowing the overall layout designer to easily make the modifications needed to fit the sections onto the complete board.

The design methodology employed different schematics and different board files, which were pulled together by a single schematic referencing the board sections as library objects. Changes to each section could be made in the library or in the original board file.

During the evolving design, the team found it best to make changes only in the original board file, as this file would represent the design base and could be linked directly to the board-section schematic. This meant that the library would have to be updated by first updating the board file, then deleting the old library board-section module and importing the new one. When a board-section module

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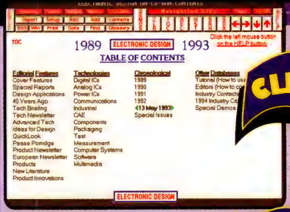

TOC

1989 ELECTRONIC DESIGN 1993

Click the left mouse button on the HELP button.

TABLE OF CONTENTS

Editorial Features	Technologies	Chronological	Other Databases
Cover Features	Digital ICs	1989	Tutorial (How to use
Special Reports	Analog ICs	1990	Editors (How to co
Design Applications	Power ICs	1991	Industry Contacts
40 Years Ago	Communications	1992	1994 Industry Ca
Tech Briefing	Industrial	13 May 1993	Special Demos
Tech Newsletter	CAE	Special Issues	
Advanced Tech	Components		
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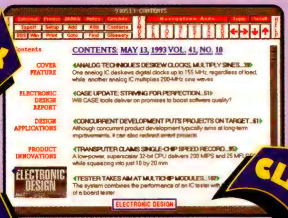

Contents

CONTENTS: MAY 13, 1993 VOL. 41, NO. 10

COVER FEATURE — ANALOG TECHNIQUES DESKEW CLOCKS, MULTIPLY SINES...39
One analog IC deskews digital clocks up to 155 MHz, regardless of load, while another analog IC multiplies 200-MHz sine waves

ELECTRONIC DESIGN REPORT — CASE UPDATE: STRIVING FOR PERFECTION...51
Will CASE tools deliver on promises to boost software quality?

DESIGN APPLICATIONS — CONCURRENT DEVELOPMENT PUTS PROJECTS ON TARGET...61
Although concurrent product development typically aims at long-term improvements, it can also redirect errant projects

PRODUCT INNOVATIONS — TRANSPUTER CLAIMS SINGLE-CHIP SPEED RECORD...95
A low-power, superscalar 32-bit CPU delivers 200 MIPS and 25 MFLOP while squeezing into just 10 by 20 mm

TESTER TAKES AIM AT MULTICHIP MODULES...102
The system combines the performance of an IC tester with of a board tester

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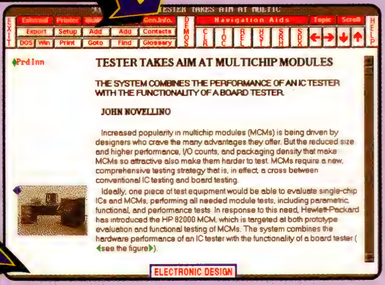

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TESTER TAKES AIM AT MULTICHIP MODULES

THE SYSTEM COMBINES THE PERFORMANCE OF AN IC TESTER WITH THE FUNCTIONALITY OF A BOARD TESTER.

JOHN NOVELLINO

Increased popularity in multichip modules (MCMs) is being driven by designers who crave the many advantages they offer. But the reduced size and higher performance, I/O counts, and packaging density that make MCMs so attractive also make them harder to test. MCMs require a new, comprehensive testing strategy that is, in effect, a cross between conventional IC testing and board testing.

Ideally, one piece of test equipment would be able to evaluate single-chip ICs and MCMs, performing all needed module tests, including parametric, functional, and performance tests. In response to this need, Hewlett-Packard has introduced the HP 82000 MCM, which is targeted at both prototype evaluation and functional testing of MCMs. The system combines the hardware performance of an IC tester with the functionality of a board tester (see the figure).

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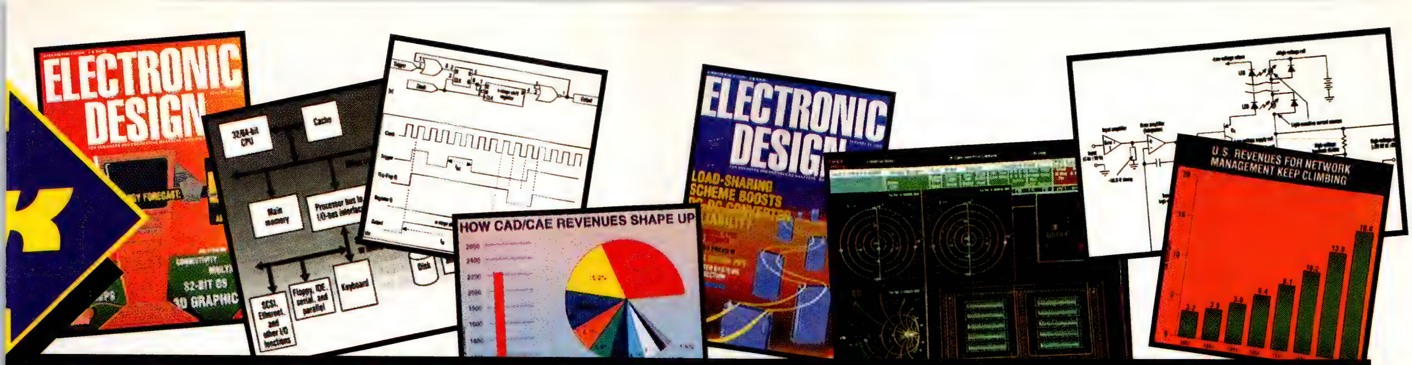
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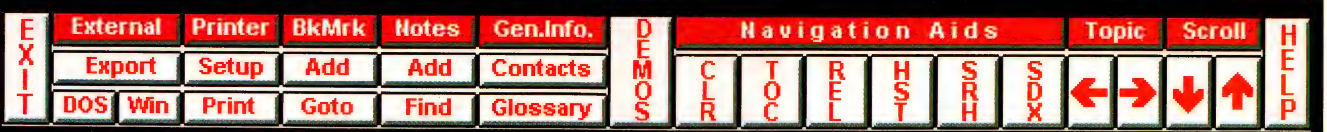

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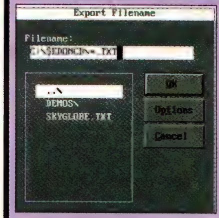

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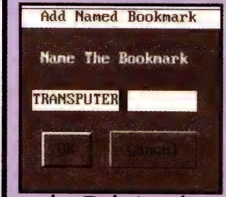

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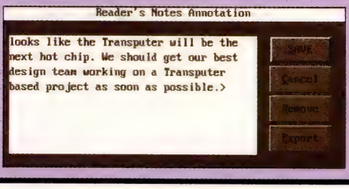

looks like the Transputer will be the
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based project as soon as possible.>

Gen. Info - Complete reference

Contacts - Company names, addresses, contact names, phone numbers- all of the information you need to follow up.

Glossary - Full article glossaries, provided by the Editors of Electronic Design magazine. The CD also comes with **WORD LINK**, which allows you to click on any word within the article and if it's in the glossary, the definition pops up. When you're done, a simple click and it's gone.

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CLR - *Clear Back Links* - Because every article you move to loads into RAM, this function allows you to clear articles you've finished. This frees up RAM for you to continue.

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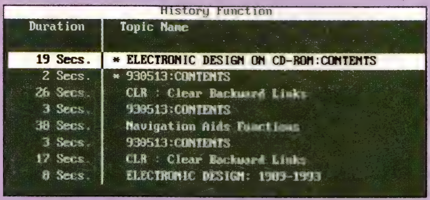

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 Duration   Topic Name

 19 Secs.   * ELECTRONIC DESIGN ON CD-ROM:CONTENTS
  2 Secs.   * 930513:CONTENTS
 26 Secs.     CLR : Clear Backward Links
  3 Secs.     930513:CONTENTS
 38 Secs.     Navigation Aids Functions
  3 Secs.     930513:CONTENTS
 17 Secs.     CLR : Clear Backward Links
  8 Secs.     ELECTRONIC DESIGN: 1989-1993
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REL - *Show-Related Articles* - Calls up a list of, and lets you move to, related topics.

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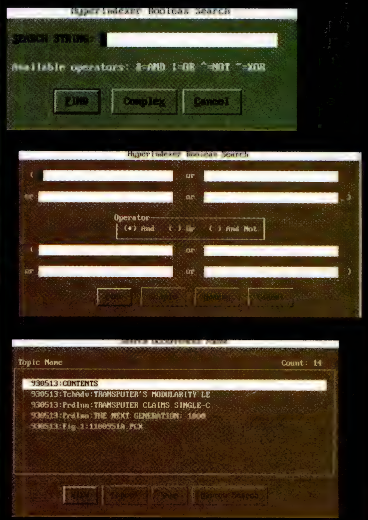
SEARCH dialog boxes

Simple search (top), Complex Search (center), and Search occurances found (bottom).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930513:TchAdv:TRANSPUTER'S MODULARITY LE
930513:PrdInn:TRANSPUTER CLAIMS SINGLE-C
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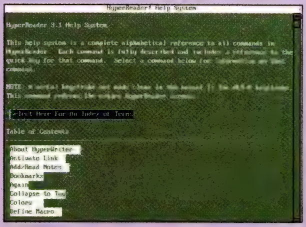

HyperReader 3.1 Help System

This help system is a complete alphabetical reference to all commands in HyperReader. Each command is fully described and includes a [illegible] to the quick key for that command. Select a command below for [illegible] command.

NOTE: [illegible]

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- ☞ 1 meg ram
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was modified for use as a new module in a different design, a new name was given to the modified module. This was true whether the change was to the schematic or to the layout only.

In the case of a layout-only change, it was decided to use the same schematic and part number for the section and change only the package description. This maintained a similarity in process to a single off-the-shelf part with multiple packages. Each board had its unique very-high-level schematic that showed the interconnection of the board sections. The board sections were archived in the same manner that gate arrays and FPGAs are archived with a schematic and packaging definition, in this case a board file.

Setting up the library for these board-section parts and encouraging reuse of the parts brought out an interesting need in the tools used by the design engineering group. Because a board section now was being considered as a module that could be tailored to a particular use, the design engineers needed to have the ability to view and modify the board-section modules. To use this approach effectively meant that they required the same layout tool (or a subset of that tool) used to layout the board. Furthermore, the description of the board-section modules had to accompany the module, and a text file was incorporated into the board-section archive.

The analog section was later used in a two-layer board design. However, the power and ground pins had to be routed in this design, which meant adjusting the placement of parts. Anticipating this requirement from the beginning could have saved some re-layout time; however, having a functioning layout to begin with did result in a significant time savings for the design team. ☐

Dick Gomez, OrCAD's product marketing manager for layout tools, holds a BSEE from the University of Vermont, Burlington.

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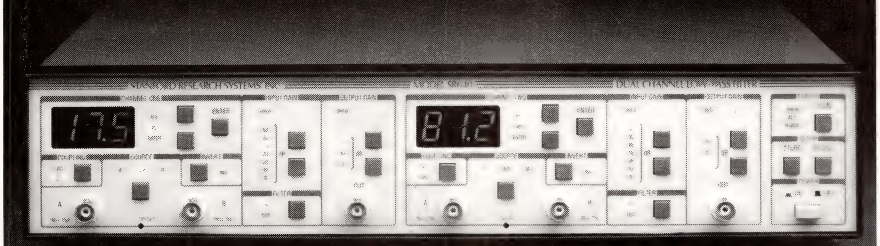

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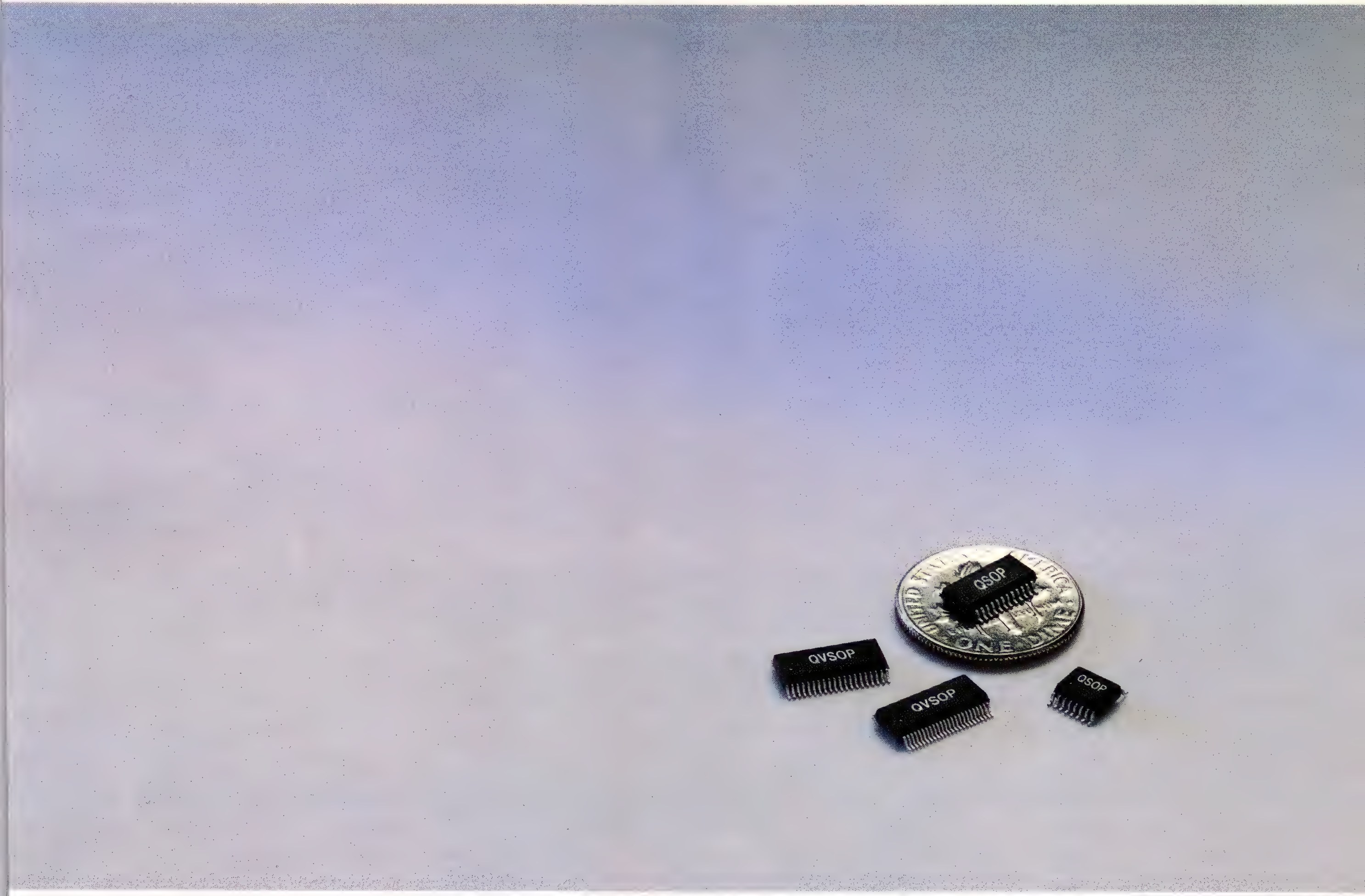

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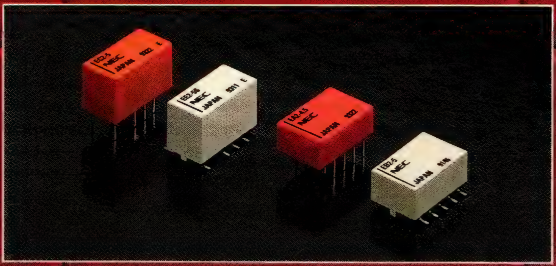

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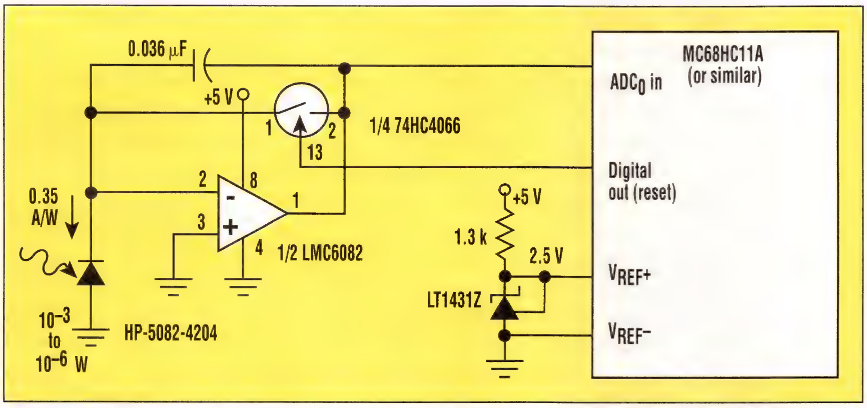
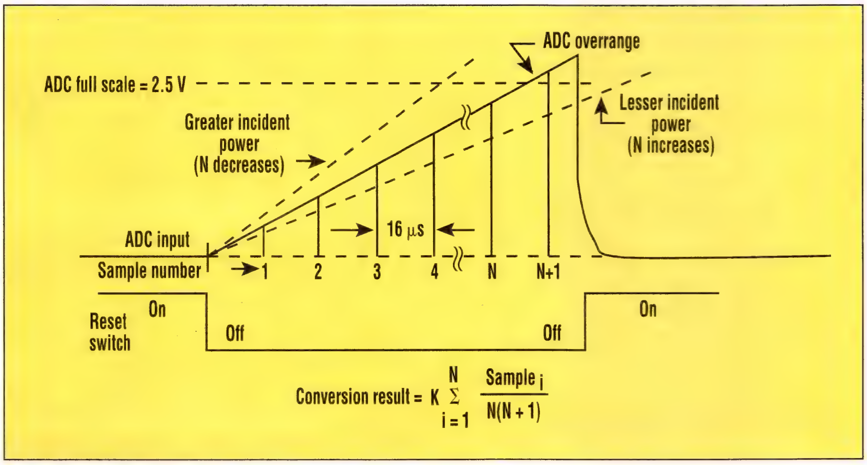
W. STEPHEN WOODWARD
Venable Hall, CB3290, University of North Carolina, Chapel Hill, NC 27599-3290.

Extending the dynamic range of ADCs is done through various standard methods, such as using software-controlled gain blocks (autoranging circuits) and logarithmic amplifiers. Both of these techniques involve additional circuitry of substantial complexity. In particular, when utilizing antilogarithmic routines, rather complicated software is needed to decode the output of a log amp. On top of that, neither technique does anything to improve analog-to-digital converter resolution.

The method described here offers an alternative for most low-frequency applications requiring an ADC performance "stretch." The basic idea is to place a resettable analog integrator in the signal path before the ADC. At the start of conversion, the integrator reset is released so that a linear ramp with slope proportional to the input is presented to the ADC. The ADC then periodically samples the analog ramp. The digital conversion values that result are summed and the process continued until either the ADC input reaches full scale, or a predetermined maximum number of conversions have been summed.



1. "STRETCHING" ADC performance for low-frequency applications, without adding complex circuitry, is illustrated here in this circuit for a photometry application.



2. A RESETTABLE ANALOG INTEGRATOR is placed in the signal path before the ADC. When conversion begins, the integrator reset is released so that a linear ramp with slope proportional to the input is presented to the ADC. The ADC then periodically samples the analog ramp.

Dividing the sum obtained by a normalizing factor given by N(N + 1)/K will convert it to a linearized result. N is the number of samples summed and K is a convenient scaling constant. Properly selecting the time constant of the integrator and the maximum value for N will yield a composite ADC of almost unlimited resolution and dynamic range.

The true power of this technique becomes clear when it's seen that the dynamic range (i.e., maximum full scale/minimum LSB) of the composite converter is proportional, not to N, but rather to N squared. As a result, if a maximum of as few as 64 samples and summations are allowed, the dynamic range of a humble 8-bit ADC is still stretched to more than 120 dB, or 1,032,192 to 1.

An example of this technique is in a photometry application in which the output of a PIN photodiode (HP-5082-4204) is monitored over an incident power range of 10^{-3} to 10^{-6} W *(Fig. 1)*. The ADC used is the 8-bit device built into the MC68HC11 microcontroller, which has a conversion time of 16 μs and an input range of 0 to 2.5 V.

The composite converter has a conversion resolution of 12 bits or better over the full 3-decade power range. This power range and resolution combine in a dynamic range of 4,096,000 to 1 = 132 dB = 22 bits. Figure 2 outlines the circuit's operation.

The 0.35 A/W (@900 nm) sensitivity of the diode, together with C_1, yields a ramp rate of 9722 V/s at 1 mW incident power. Therefore, 257 μs are needed to ramp to the ADC input limit of 2.5 V. As a result, 16 samples will be summed before ADC overrange, producing 12-bit resolution at that power level.

Decreasing power levels lead to longer ramp times to ADC full scale, until the preset maximum for N is reached. A maximum N value of 512 was selected to maintain 0.25×10^{-9}-W resolution at power levels below 3×10^{-5} W. Maximum conversion rates thus vary from around 3 kHz (16 samples) to 120 Hz (512 samples) as the incident-light power level varies from 10^{-3} to 10^{-6} W. Unsigned, 16-bit integer arithmetic is sufficient for summation of the ADC samples (the maximum sum is 65280). However, note that extended integer or floating-point representation is necessary for the linearizing division and for expression of the 132-dB (22-bit) dynamic range of the result.☐

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CIRCLE 521

VERY-LOW-NOISE 5-V REGULATOR

WALT JUNG

Analog Devices, One Technology Way, Norwood, MA 02062-9106; (410) 692-6702

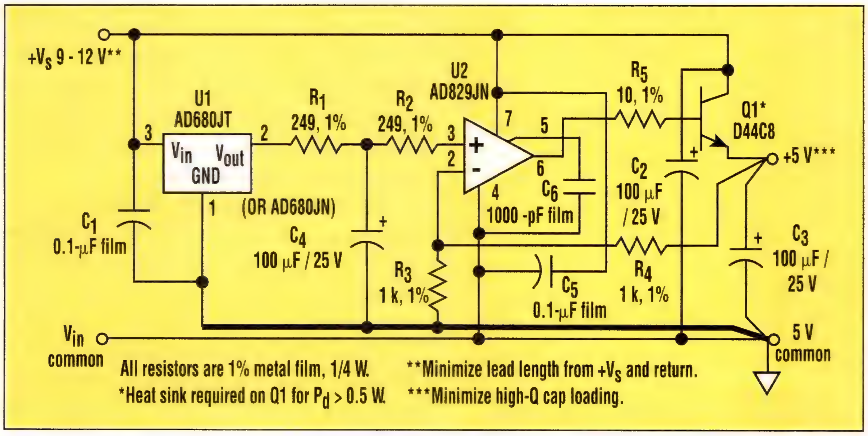
The common "7805" series of three-terminal 5-V IC regulators have become near universally used for logic power. Though quite attractive from mutual standpoints of utility, simplicity, and cost, 7805-type regulators really aren't optimum for the highest performance applications. One particular instance involves systems that share 5-V power between analog and digital stages, and low-noise analog circuits become contaminated by logic-related noise. Where lowest output noise, highest line rejection, and lowest wideband output impedance are critical, more complex 5-V regulators are better choices. Examples of applications with such demands include the powering of supply-sensitive, low-noise phase-locked loops; logic stages that must operate with low jitter; and other supply-critical circuits, either analog or digital.

These performance issues are addressed by the circuit shown, which uses two ICs and a discrete pass transistor, plus a handful of passive components *(see the figure)*. In operation, the 2.5-V output from the AD680 TO-92 reference U1 is noise-filtered by R_1-C_4, then amplified to 5 V ±2.5% by op amp U2 and Q1. The output level is set by scaling resistors R_3 and R_4. This ratio can, of course, be adjusted for outputs other than 5 V, following the standard op-amp noninverting gain equation. The 4-A-rated D44C8 specified for Q1 allows current outputs of 400 mA, with TO-220 package dissipation. Lower current applications can use a TO-5 device, such as a 2N2219. The design has no current limiting, so the source should be fused or otherwise protected for maximum current.

Several circuits details will enhance ac performance for noise, supply rejection, and output impedance. Low noise is achieved via three measures: the use of a $2\ nV/\sqrt{Hz}$ op amp (the AD829); relatively low impedance for both R_3-R_4 and R_1-R_2; and 6-Hz corner low-pass filtering of U1's reference noise. The net result is an output noise density less than $10\ nV/\sqrt{Hz}$ at 1 kHz, 10 or more times lower than a (good) 7805's typical $125\ nV/\sqrt{Hz}$. The wide bandwidth of the AD829 and the use of external compensation will provide high line rejection, 90 dB or more up to 10 kHz. Combined with high dc gain, this also allows an output impedance of 5 mΩ or less below 20 kHz, dropping below 1 mΩ for 7 kHz or lower frequencies—figures about 10 times better than a 7805. Note that the four-terminal output connections used as shown are necessary to realize this level of performance at the load, a feature that's simply not possible with three-terminal regulators.

Because this is a high-performance circuit, component substitution should be minimized to realize the results quoted. While passive components aren't critical for basic functionality, best performance is attained with a low-leakage and low-ESR C_4, and metal-film types for all resistors. Input bypass C_2 may not be needed if the raw dc filter capacitor is within a few inches. Output capacitor C_3 is a conventional electrolytic type, but high-Q (low ESL/ESR) capacitors should be applied carefully. Because of the wide regulator bandwidth, these types should be decoupled at the load by low DCR chokes or ferrite beads. Noise can be lowered further if desired by increasing the size of C_4 and lowering R_2, R_3, and R_4, with, of course, the tradeoffs of C_4 size and overall standby power.

This circuit was tested with supplies as low as 9 V, with 1-V rms ripple superimposed. If lower dropout performance is necessary, a rail-to-rail output device like the AD820 can be used for U2, deleting C_6. This change will affect noise and bandwidth somewhat, but it does have the advantage of allowing operation from inputs down to 6 V (or less). This is because U2 under these conditions can drive the Q1 base to within a few millivolts of the input rail.☐



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Ins. Loss (dB)	1.1	1.4	1.9	0.9	1.3	1.4
Isolation (dB)	42	31	20	50	40	28
1dB Comp. (dBm)	18	20	22.5	20	20	24
RF Input (max dBm)	—	20	—	22	22	26
VSWR "on"	1.25	1.35	1.5	1.4	1.4	1.4
Video Bkthru (mV,p/p)	30	30	30	30	30	30
Sw. Spd. (nsec)	3	3	3	3	3	3
Price, $ (1-9 qty)	YSWA-2-50DR (pin) 23.95 ZYSWA-2-50DR (SMA) 69.95			YSW-2-50DR (pin) $14.95 ZYSW-2-50DR (SMA) 59.95		

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F141 REV. D

CIRCLE

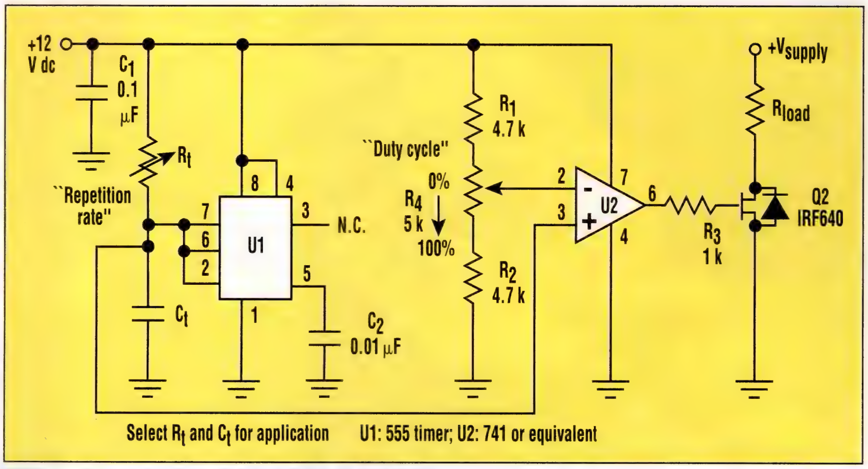
522 VARY REP RATE, DUTY CYCLE WITH A 555

JEFFREY A. HARVEY
VE1BLL, Box 960, Enfield, Nova Scotia, Canada B0N 1N0; (902) 873-2000.

I once had to solve a problem similar to that discussed in *Electronic Design's* January 24, 1994 Ideas for Design column *("Vary Rep Rate, Duty Cycle Separately," p. 78)*. The project was to design a digital tachometer and dwell meter. I needed to simulate the primary side of an automobile ignition circuit with rpm (repetition rate) and dwell (duty cycle) both independently variable.

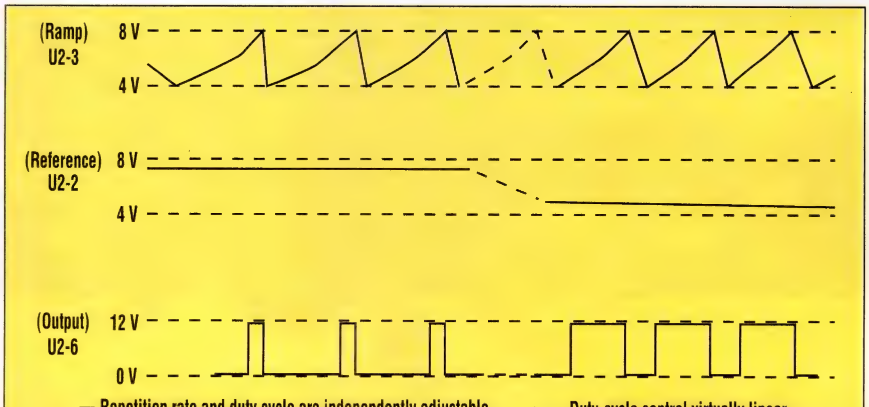
The circuit is based on the concept of using a 555 timer to produce a ramp waveform, and then comparing this ramp to an adjustable reference. The resulting device is very simple and uses garden-variety components *(Fig. 1)*.

The ramp waveform (at U2-3) oscillates between 4 and 8 V *(Fig. 2)*. The reference (at U2-2) is adjustable from a value of slightly less than 4 V to slightly more than 8 V. When the ramp exceeds the reference level, the op-amp output (U2-6) goes high and turns on the FET.☐



Select R_t and C_t for application U1: 555 timer; U2: 741 or equivalent

1. TO INDEPENDENTLY VARY rpm and dwell, or duty cycle, a 555 timer is used to produce a ramp waveform, which is compared to an adjustable reference.



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— Duty-cycle control virtually linear.

2. THE RAMP WAVEFORM oscillates between 4 and 8 V. When the ramp exceeds the adjustable reference, the op-amp output goes high and turns on the FET.

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We recently expanded the Ideas for Design section to include more items in each issue. To continue this expanded section, however, we will need a steady flow of ideas.

We depend on our readers to keep this section going. This is an opportunity for our reader-engineers to gain recognition for, as well as share, their innovative ideas with other engineers throughout the world. Issue after issue, Ideas for Design is voted highest on the "Of Interest" scale in our reader surveys. We pay $100 for each Idea for Design we publish, and the IFD voted best of the issue brings the author an additional $150.

Submissions to the Ideas for Design section should be about one typewritten page of text, with one or two circuit diagrams or block diagrams. They should represent the author's original work, be tested to prove they actually work, and not have been published previously. Please include telephone and fax numbers, if available.

Send your Ideas for Design to:

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Electronic Design
611 Route 46 West
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CIRCLE

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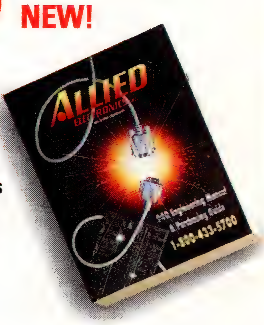

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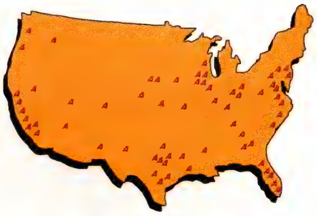

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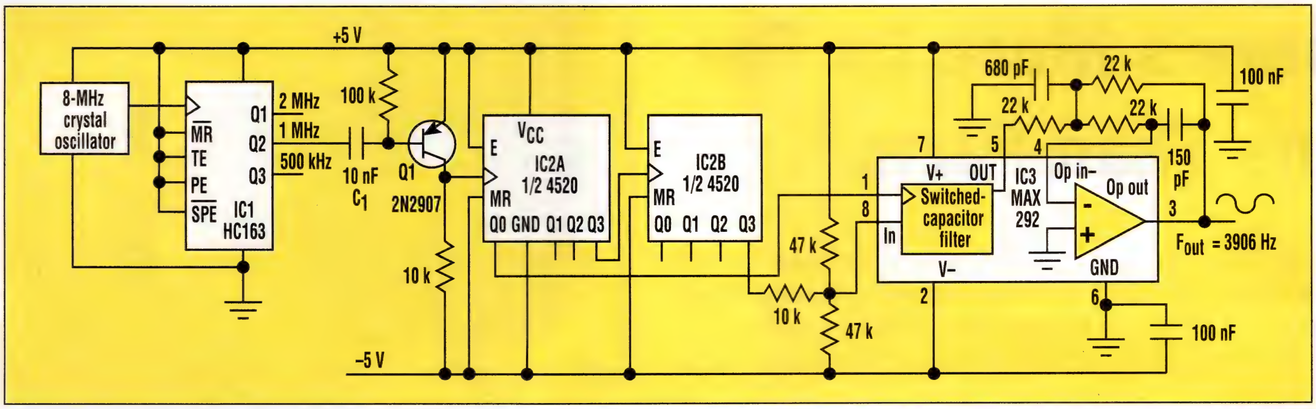


FILTERING the harmonics from a squarewave produces a sinusoidal output whose stability and flexibility derive from digital circuitry.

er accuracy and less drift is to derive the sinewave from a digital source. Because squarewaves comprise a fundamental at the squarewave frequency plus an infinite number of harmonics, the desired fundamental sinusoid can be obtained by removing the harmonics with a low-pass filter. Switched capacitor filters suit this type of application *(see the figure)*. For instance, IC3 is an 8th-order, low-pass Butterworth type.

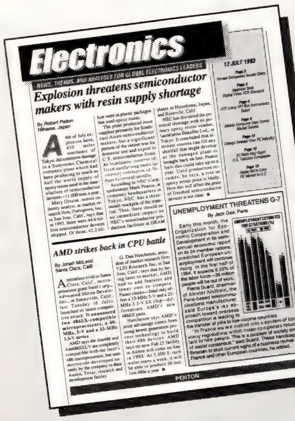
The sinewave generator starts with an 8-MHz signal and divides it by eight to obtain 1 MHz at C_1 (IC1's 2-MHz and 500-kHz outputs can serve as alternate drive signals). Q1 level-shifts the 1-MHz pulses so that they can drive the bipolar circuitry necessary for producing a bipolar output (for unipolar outputs, the circuit can operate on a single-supply voltage by biasing the IC3 ground terminal to mid-rail and adding a decoupling capacitor). Synchronous counter IC2 divides 1 MHz by 256 to give the desired output frequency (3906 Hz), and IC3 filters the harmonic frequencies.

The filter's clock is taken from the first divide-by-2 tap of IC2 to assure a 50% duty cycle. IC2 further divides this signal by 128 to assure that the filter's input signal (1 MHz/256) falls within the flat portion of the filter response. The IC2 outputs' 50% duty cycles assure a symmetrical sinewave output. The filter's major pole, or corner frequency, is fixed with respect to the clock and forms an internal clock-to-corner ratio of 100:1. Filter attenuation lowers the third-harmonic amplitude to –80 dB.

The output of the switched-capacitor filter resembles a sampled sinewave. It can be smoothed by building a first- or second-order low-pass filter around the otherwise uncommitted output op amp.

Because the filter's input and clock frequencies have a fixed ratio of 1:128, switching or sweeping the frequency applied at C_1 has a proportional effect on the sinewave-generator output. For example, switching this frequency from 2 MHz to 500 kHz switches the output frequency from 7812 Hz to 1953 Hz. Output amplitude is unaffected because this band is well below the smoothing filter's 25-kHz corner frequency.

Alias frequencies are not a problem here, because the potential cause of aliasing in this circuit—the odd-numbered harmonics that exceed half the clock rate—have insignificant amplitudes.☐



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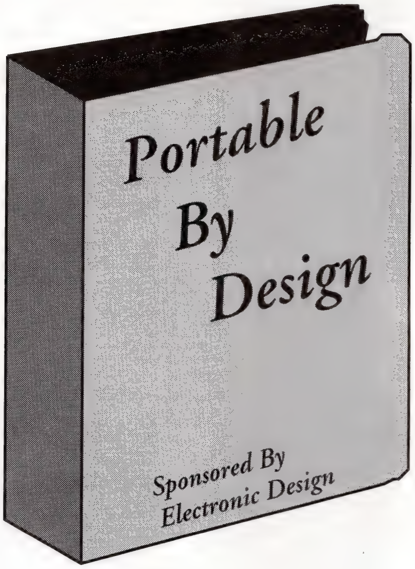

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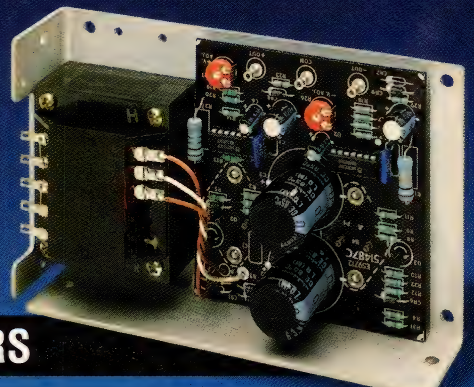

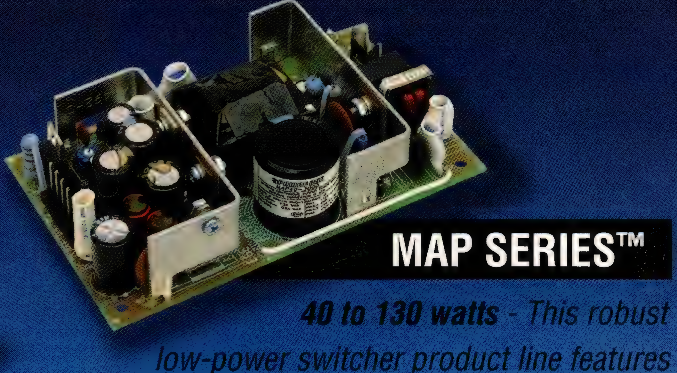

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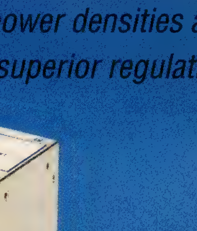

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ELECTRONIC DESIGN

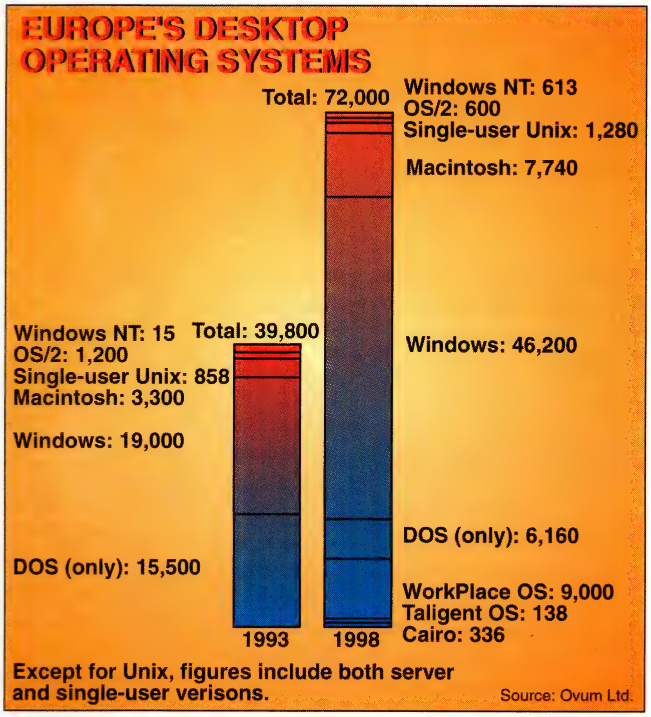
QUICK LOOK

EDITED BY SHERRIE VAN TYLE

MARKET FACTS

Introducing distributed object technology is key to winning a share of the operating systems market, according to Ovum Ltd., a London-based market research company. With applications the most compelling force behind choice of OS, the platforms that will lead the pack are those that attract the most developers, in part because these operating systems support tools for efficient development.

Other developments to watch: Novell's AppWare development system; the open development specification for the NeXTStep environment by Sun and NeXT; Taligent's object-oriented frameworks; and Microsoft's OLE2 compound document architecture and distributed object technology. Three alliances are propelling distributed object technology. Taligent, along with its backers, Apple, Hewlett-Packard, and IBM, incorporates technology from IBM's SOM (System Object Model) and DSOM (Distributed System Object Model) and Hewlett-Packard's DOMF (Distributed Object Management Facility). Microsoft with its OLE for component sharing between documents is allied with Digital's distributed COM (common object model). Sun has a stake in Iona, developer of Orbix, a machine-independent object request broker, which allows objects and non-objects to communicate with each other. Sun, of course, also has a stake in NeXT, developer of the OpenStep application environment.



EUROPE'S DESKTOP OPERATING SYSTEMS

Except for Unix, figures include both server and single-user verisons.

Source: Ovum Ltd.

TALES FROM A SKUNK WORKS

I am often asked how to best start changing toward skunk works and empowered teams. Should a firm start top down or bottom up? How can people best be empowered? What organizational structures should be set up? Remember that change is difficult. The structures, metrics, and power flow of "normal business" resists change in subtle but incredibly powerful ways. The old ways are locked in iron. In the face of this resistance, most managers and consultants give up and tweak the old processes to yield incrementally better results, but that's not enough.

A colleague, Marvin Patterson, recently told me of a chat he had with a Silicon Valley CEO. The topic was engineering productivity. "That's easy," said the CEO. "To increase productivity, I just lay off a few engineers." "Yes," said Marv. "That will work. You can get perhaps a 20% gain. Those who remain will work nights and Saturdays. Perhaps you can get them to work Sundays too. But you will never get more than 40%, because there are only seven days in a week. In contrast, the new methods can yield order-of- magnitude gains." Actually, a sustained 20% gain is unlikely. As previously reported, American Management Association data shows that 69% of the time, layoffs do not raise productivity.

Trying to mix empowerment and skunk works with "slash and burn" management is an exercise in futility. In an environment of fear and distrust, who will take risk? In an environment of insecurity, who dares eliminate work? In an environment of obedience and overload, who searches for better ways?

In his book, *The Fifth Discipline*, Dr. Peter Senge pleaded for better systems thinking. He said that our firms and social organizations often do self-destructive things for short-term benefit. So, who should start the change process? The answer is: everyone. No single individual, not even the CEO, can transform an organization on his own. You must work top down and bottom up. You need sponsors and champions and you need coaches and mentors, because what worked in the past is not what will work in the future.

To survive, the CEO needs enough headroom that he can invest in training and development. That money must come from somewhere. For each skunk works and new-age team, some other part of the organization is making sacrifices. Honor them. This process is like a parent who skimps to send children to college. The role of the leader of the skunk works is no less difficult. She will make mistakes and consume scarce resources. Success requires mutual trust, teamwork, and, of course, "that vision thing." These take time.

John D. Trudel CMC is managing director of The Trudel Group, 52001 Columbia River Hwy., Scappoose, OR 97056; (503) 640-5599; fax (503) 543-6361; e-mail address: JohnTrudel@aol.com. He is the author of High Tech with Low Risk. *To order, phone (503) 280-8547.*

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Reducing energy consumption, including that of monitors, is of increasing concern both to end users and to manufacturers who must meet government requirements to purchase only "green" monitors. To that end, an adapter and software from Optiquest reduces electrical consumption by monitors. The monnitor can be powered down to either standby, suspend, or off states. Standby and suspend take less than three seconds to restore the monitor's screen. List price for the adapter is $69.95; $29.95 for the software. For more information, contact Optiquest Inc., 20490 Business Pkwy., Walnut, CA 91789; (909) 468-3750; fax -3770. CIRCLE 461

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For a free issue of Current Events, a newsletter about OEM power and magnetic specifiers of 50/60 Hz transformers from 1 VA to 10 kVA, contact Signal Transformer Co., 500 Bayview Ave., Inwood, NY 11696; (516) 239-5777; fax -7208. CIRCLE 464

KMET'S KORNER

...Perspectives on Time-to-Market

BY RON KMETOVICZ
President, Time to Market Associates Inc.
P. O. Box 1070, 100 Prickly Pear Rd., Verdi, NV 89439; (702) 345-1455; fax (702) 345-0804

Clear goal: Make break-even time equal to, or even a bit faster than, that of the competition.

Contrast this goal with the fuzzy goal of a "10x reduction in new product development cycle time" introduced in the last column. To make the break-even time goal work, your organization must fully understand the BET concept and than discern competitive performance with respect to this parameter.

You will work on forming concepts within your organization; you will collect data about yourself and your competitors; you will analyze that data; and then you will reduce the data to show how you compare with your competition.

Determining what action to take to retain or establish a leadership position becomes an organizational issue—neither engineering, marketing nor manufacturing can do it alone—all departments must contribute.

Two cash flow profiles determine the break-even point. First, you'll need to know the flow of a new product's development money. Second, the flow of profits, resulting from sale of the new product, must be recorded. And for the good news, all accounting systems I know about make the extraction of break-even data relatively easy.

Review old records on the money spent in new product development. If you're like most firms, you'll find cost data on every project. The data should reveal spending patterns on engineering, marketing, and manufacturing. Decompose how each function spends its money to better understand the working details. Then reassemble the data, after making learning related adjustments, to produce the investment profile. As you take these steps, interval timing issues surface. Did accounting project expenses start soon enough? Did accounting stop at the right point in time?

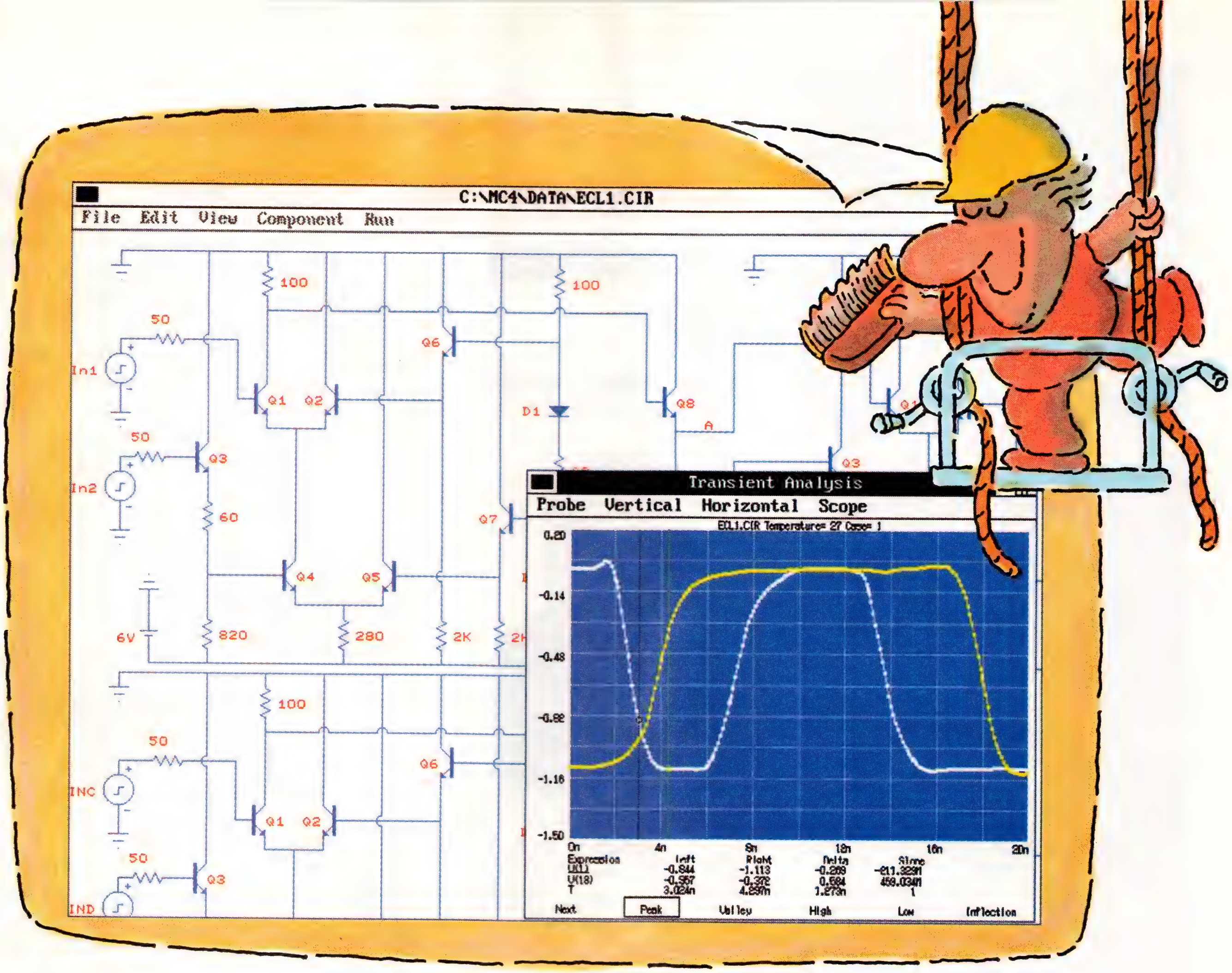
The presence of data forces the definition of start and stop points for acceptable development cost for your business situation. Assigning engineers to work on a project generally starts the measurement of the break-even interval. Sometimes project accounting begins somewhat later. Find our how your organization accounts for projects in their formative stages. If useful data cannot be found, develop alternative measures to estimate development cost from the time staff actually began work on the effort—real work and real moneys go together.

A simple and surprisingly accurate method, based on cross-functional resource profiles, often supplies the needed data. You just reconstruct the staffing profiles to get the product to market and multiply by a financial scaling factor to arrive at total development cost. The development cost end point exists near the point when the product begins its sales life. Confront and then decide upon the inclusion, or exclusion, of sustaining engineering money in your development cost analysis.

Charting sales and resulting profits derived from sales should be staightforward—in point of fact, your company needs this data to satisfy Internal Revenue Service requirements. There may, however, exist a few numerical challenges in breaking the data into the components you need. Here, some help from a friend in the finance department makes for a happy day.

Construct break-even graphs for products introduced within the past three years. Study them and learn from them. I'll move this concept forward in the next issue.

Ron Kmetovicz's The One-Minute Time to Market Self Assessment, which identifies five key behavioral patterns exhibited by fast-moving new product development organizations, is available free to the readers of Electronic Design by contacting Time to Market at the address above.



Expression	Left	Right	Delta	Slope
V(1)	-0.844	-1.113	-0.269	-211.329M
V(18)	-0.957	-0.372	0.584	459.034M
T	3.024n	4.297n	1.273n	1

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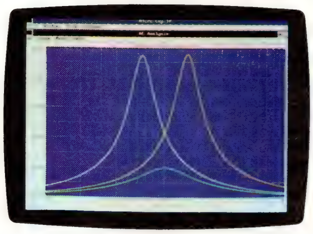
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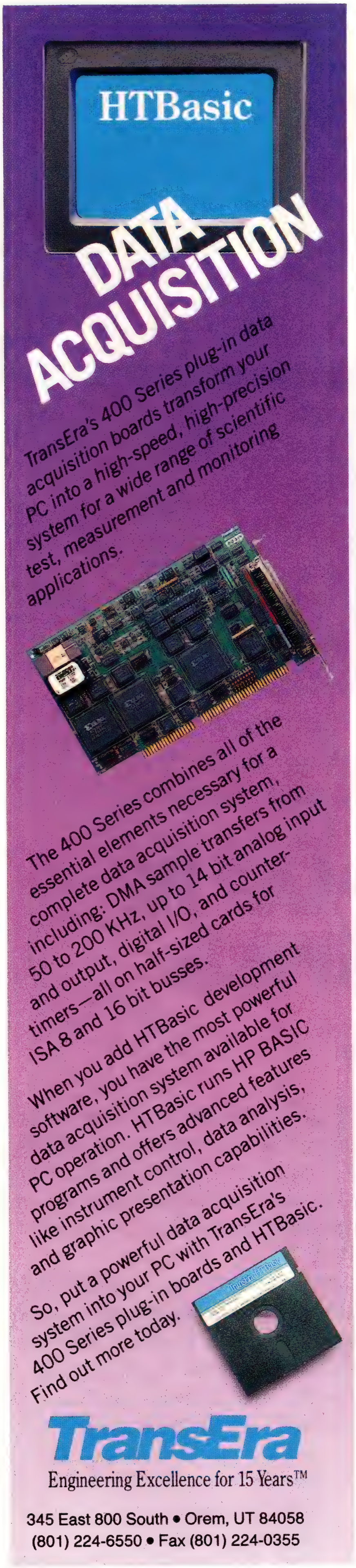

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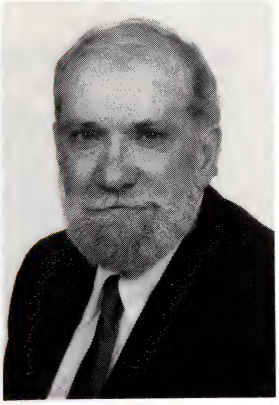
...Generational wars

BY FRANK J. BURGE

Director of Market Development for Electronic Design



My friend Sid Speigel had a sign on the back of his office door: "Just because the psychiatrist says you're not paranoid doesn't mean they're not out to get you." Paranoia sometimes increases with age. But I do believe there is conflict between the generations—conflict born out of downsizing, competition in the job market, and the understandable desire for young people to move up as rapidly as possible.

Now I first got turned on to this age issue when I read a great piece in our company newsletter written by Sal Marino titled: "What did you do in the generational wars daddy?" Sal, now in his early 70s, started his career at Penton Publishing more than 40 years ago as a promotion specialist. He's now chairman and CEO. What follows are Sal's pearls of wisdom, unedited:

"Recent articles in both consumer and business publications have alerted me to the tensions between baby boomers and their twenty-something descendants, the baby busters. Since my reading also tells me that in the 21st century, a man's life expectancy is expected to increase to 80 and a woman's to 89, I started wondering what might happen half a generation from now, when boomers, busters, and some of us hangers-on from the 'big band' era are all shifting around in the workplace.

"Imagine life at Penton in the year 2010. I'm 90 years old and back to being a promotion specialist. I ask my new boss, 'How old are you, young man?' He replies, 'That's hard to say. According to my latest school tests, I have a psychological age of 50 and a moral age of 30. Anatomically, I'm 25; mentally I'm 60ish. If you're referring to my chronological age, that's only 21. But nobody pays any attention to that nowadays.'

"Well, I'm paying attention. This fresh-faced whiz kid is my boss. I am almost five times his age. A 58-year veteran and former CEO, I have outlasted six immediate supervisors and three chief executive officers. Here I am, facing a creature who has not one age like normal human beings but one for each aspect of his character. He is a cookie-cutter junior executive in Brooks Brothers' herringbones, tasseled loafers, button-down shirt, repp tie, and modified motorcycle-cop rimless eyeglasses. As I look into his mind through his eyes, I see 100 Mbytes of memory inside his head, full of Drucker, Toffler, Levitt, Herzberg, and Peters. His Phi Beta Kappa key bounces slivers of light off my trifocals. Panic grips me. I am convinced he's going to 'get me.' This MBA is going to edit my copy, raid my idea file, peek into my brain, probe my psyche, and wreak havoc with my stomach acid. At my age, I think to myself, and with my experience, I don't deserve this. If our society had any respect for its elders, I'd be testing his 'software.' Instead, he'll be testing mine.

"In less than 30 seconds, this young man has become the enemy. I suspect my business-school certified, instant executive boss of looking for a way to keep me from celebrating 60 years with Penton. He suspects me of wanting to be the first centenarian promotion manager in company history.

"We are at war. Fiction? Or prediction? In the next century, fiction like this could become reality. Battles like my imaginary one will pit 'Ageless Wonders' against 'Baby Zoomers,' youth against age, generation against generation. New intergenerational conflicts will make the generation gap of the '60s look like a crack in the pavement. Don't worry, folks. I don't plan to work until I'm 90. And those of you who are on the battlefield in 2010, don't forget I warned you."

Sal, you hit the nail on the head. Thanks a bunch.

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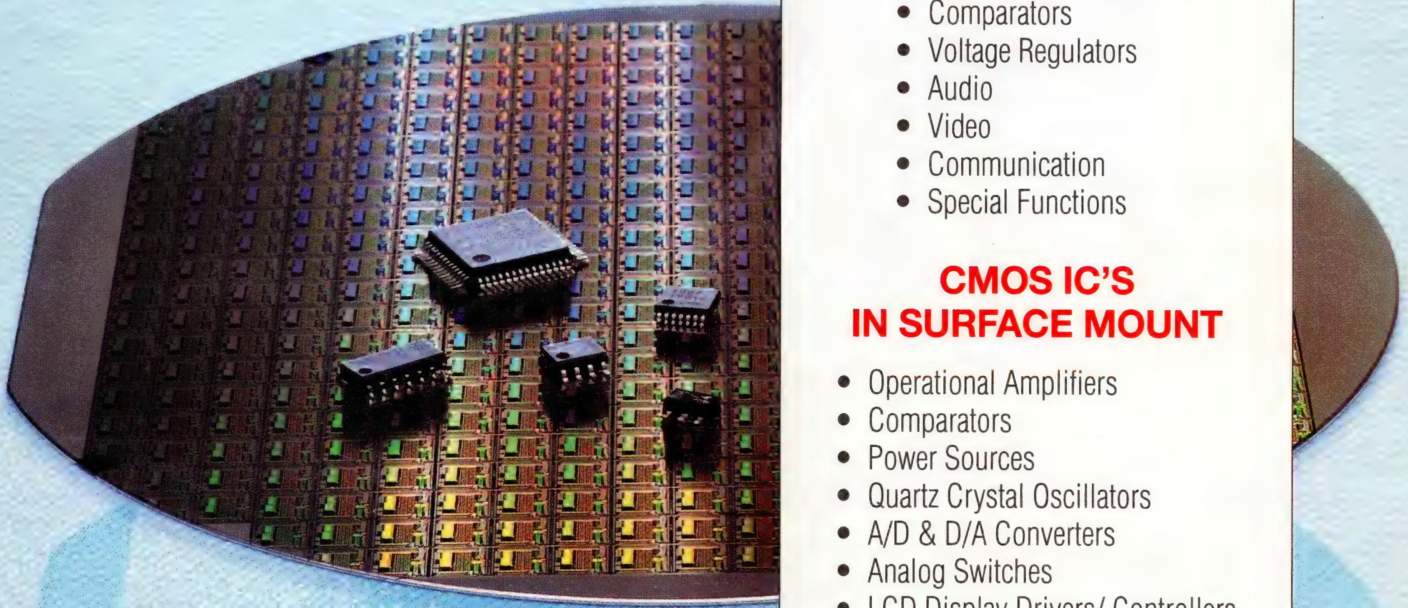

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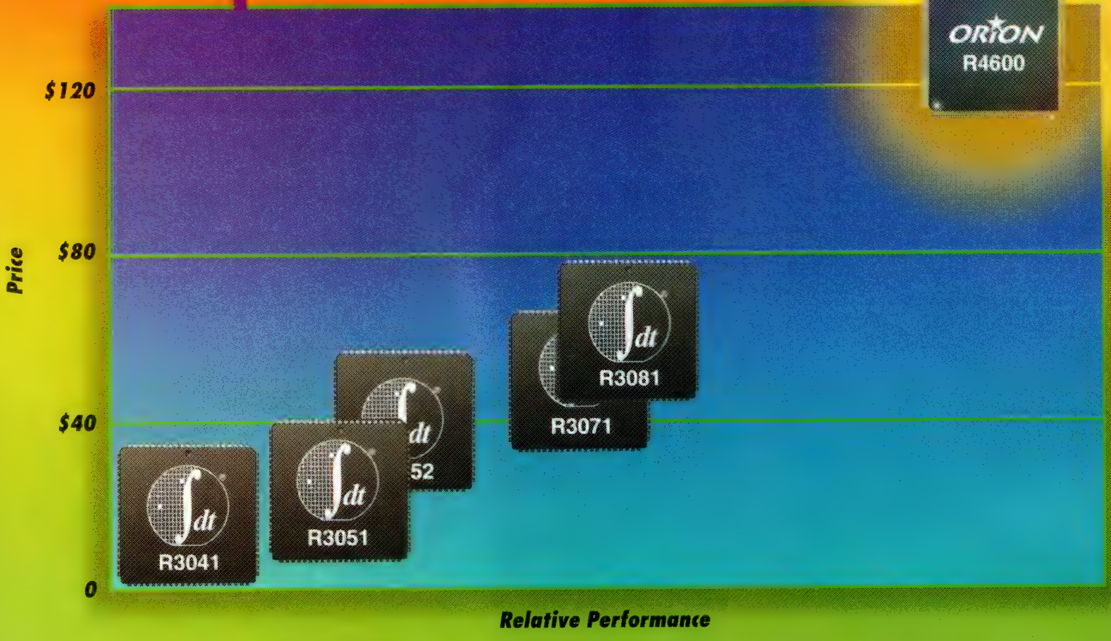

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PEASE PORRIDGE

BOB'S MAILBOX

Dear Bob:

I enjoyed your February 7, 1994 column about the testing controversy. I helped to develop a very sophisticated microwave instrument when I worked for the High Priced company. It sold for about \$45,000 at the time (and is over \$60,000 now). The instrument was very complex, so every unit was placed in a burn-in chamber for a week.

The production manager, ever searching for a way to maximize profits, saw all of this finished goods inventory sitting there, wasting floor space and representing \$\$\$\$ that were not flowing into the corporation in a timely manner. So he decided that this burn-in would no longer be required.

Luckily, we kept data (failures, test data, etc.) on all of these instruments, so I was able to show that each and every instrument failed at least once during the burn-in period! Because the standard warranty period for the instrument was one year, I was able to show that it cost the company less (due to warranty costs) to burn-in the instruments than to eliminate the tests. And we had a lot fewer unhappy customers. Logic and the bottom line prevailed when I showed this data to the division manager. (The production line was not charged for warranty costs in the accounting system, so the production manager did not see these costs in his budgets.)

The moral of this story is that complex instruments fail in complex ways, and that it is important for the manager that produces the unit to be charged for the problems.

We also used the failure data to redesign some circuits when a design problem could be identified. Many problems appeared to be simply random component failures. (If a million 1-Ω resistors were placed in a series combination, and if the failure rate of each resistor were 1×10^{-6}, what is the failure rate of the resistor string?)

LARRY MARTIN
Larry Martin Consulting
Sebastopol, Calif.

Gee, did Mr. Deming ever decree, "Thou shalt not burn-in your equipment before final test?" I don't think so! If those 1-Ω resistors tend to fail short, that's not so bad. If they fail open, you'll be busy trying to keep that resistor working!—RAP

Dear Robert:

"Floobydust." I first saw that word sometime in the early 1970s. It was used in one of National's application manuals. I plowed through my library and came up with *Linear Applications, Handbook 1*, dated 1973, and *Linear Applications, Handbook 2*, dated 1977. The 1973 book is rather battered, worn, and wrinkled. The pages are yellow and marked here and there with notes written in red. The 1977 book also is beat up, but the pages are still white—a better quality paper. Sitting adjacent to Handbook 1, on its right side, used to be an application manual that concerned itself with audio. In 1978, I made the mistake of loaning the book to a kid just coming along. Always a mistake, because loaned books are lost forever. In any case, the word FLOOBYDUST was used in that book as the title of the section describing various signal distortions that could be induced, and the circuits used to create those effects.

I'll probably never have a use for that book again, but it is imperative that I have it in my library. So, if you search the archives of National and come across the book, I would certainly appreciate receiving a copy if one is available. (Actually, you can never tell. A couple of weeks ago, I had occasion to look up some data concerning a 6SN7 in the *RCA Receiving Tube Manual*, circa 1950.)

While I'm at it, I've been trying to drop you a note for some years now concerning one of the helpful troubleshooting tricks described in your series on analog whatever. I remember your suggestion of shunting points in physical circuitry with handheld radial capacitors. Well, sometimes oxidation prevents electrical contact at the end of the leads and whatever it is you are trying to shunt. It is best to take a pair of cutters and cut the leads at a sharp bias, say 60 degrees. This puts a sharp point on the end of the leads, and very effectively pierces any insulating coating that may exist. Blood is very corrosive, so care is required. When not in use, the capacitors can be stored with the end of the leads pushed into a cork. That's a good storage device for test leads employing steel phonograph needles in chucks as probes. I wish I could find some of those probes. Maybe you'll come across a couple of those while searching for the Manual, if you decide to look.

PETER L. KROHN
Easton, Pa.

I agree, old books are valuable, and hard to keep track of. I'll send you a photocopy of the old Audio Handbook for your library. Yes, a capacitor with its leads cut diagonally does make a better probe than other components. I have a collection of old corks for that use, too.—RAP

Dear RAP:

I purchased a "GreenPlug" for my refrigerator and I am very pleased with the improvement. The refrigerator runs quieter and the automatic icemaker works better than ever.

Supposedly, it is based upon NASA technology (whatever that means). I suspect it is a simple filter, or a circuit based on fuzzy logic, etc. Could you enlighten me on its operation? Does it *really* save electricity? Outwardly, the claims seem too good to be true, but it is doing something.

I have a difficult time believing a device so inexpensive (less than \$30) works so well. I would appreciate your comments, and perhaps a solicitation of comments from others who have used the GreenPlug.

KEN McRAE
Bellevue, Wash.

I've been hearing about the NASA circuits for a long time. They couldn't

PEASE PORRIDGE

make it work 20 years ago; maybe now they finally got it working. Ask the manufacturer for a copy of the report from the independent testing lab, which will prove that it saves you energy and money at high line and low line. Or, wait to see what "Consumer Reports" says.—RAP

Dear Bob:

I just read your "What Is All This Apples and Oranges Stuff, Anyhow?" article in the May 2 issue. Amen.

I think the best example of the problems of JIT for the electronic industry, and how 3- or 6-month lead times for ordering is shooting it in the foot, is my recent attempt at getting a small quantity of a part for personal use.

I got a flyer from a company (not NSC) talking about a new ADC. It would be perfect for a project I was thinking about working on, if I could only find a cheap, simple 12-bit ADC that talked to the Motorola 68HC11 without a lot of brouhaha. This part did it all for about $20.

I called the distributor. No, sorry, none in stock, three months lead time. I called several places, such as Digikey. No, sorry, none in stock, three months lead time. Well, most of the time, if I had to wait three months before I work on a project, that project doesn't get worked on, and I did want to try this one. I called the manufacturer. They surely could sell me three of the parts.

No, sorry, none in stock, three months lead time. BUT they forwarded my call to the samples department. Sure, two pieces for free as samples, no problem.

What a wonderful system. Here I was ready to give someone money for something and I couldn't get anyone to take it. If only the IRS worked on JIT. A company is actively advertising its products, but was not planning on having any ready to sell for the next three months. Amazing.

This is not the first time I have run afoul of long lead times and ADCs. That was many years ago when I blew up the only 12-bit ADC I had on hand, and learned it would put my PhD research back 6 months waiting for another. What I learned from that was that an 8-bit DAC and a comparator, along with some small bit of software, makes a dandy successive-approximation ADC, and that systems with enough noise don't need the extra four bits anyway.

JOHN STANLEY
Corvallis, Ore.

IC availability comes in only two flavors: the parts are available and the customers aren't, AND vice versa. Sigh.—RAP

Robert!:

I was delighted with your Pease Porridge feature in the May 2 issue of *Electronic Design*. Our country is awash in wannabe educators who believe simplified approaches are warranted....lest we overstress the student's gray matter and turn 'em off. About 1/3 of the way through your article, I was thinking "I need to send Bob a copy of *The Goal...*" I could not have been more pleased to read your recommendation of this fine work later in the article.

You've reinforced a growing concern I have about our passion for simplistic models of complex systems. Case in point: Our government is spending billions in public and private money ostensibly for the enhancement of aviation "safety." An ongoing endeavor is to electronify the task of keeping airplanes from getting together in mid-air. This event is so rare statistically that rational analysis of cause and effect is very difficult. Taken as a whole, if two airplanes munched together every day, you'd still have to make a flight a day for years before standing a good chance of being an attendee at a disaster. (OOPS! Pardon my simplistic model.) The causes are so variable and intertwined that taking control of independent variables is virtually impossible.

Nonetheless, we *will* have some form of warning system in the cockpit. Pilots will report making all kinds of evasive maneuvers as suggested by the squawking device on the panel. Obviously, each action will narrowly avert a disaster so that politicians will deem the project a grand success and justify expenditures. However, I suggest that pilots will (1) become complacent and abrogate yet another pilot responsibility (keep your head up and eyes open) to a black box, and (2) become tired of making so many evasive maneuvers and begin to ignore the equipment. In any case, the newcomer to the cockpit will become yet another distraction and raise, not reduce, the probability of disaster.

Many people trust the ability of news "analysts" and politicians to pass judgment upon cause and effect based upon no science, no hard data, and, therefore, no real analysis. Risk assessment is never a part of the thinking. We'll spend billions (to save a human life or two) and accomplish little or nothing in aviation, while failing to spend a few millions on roads and bridges which would probably save many, many more lives.

I am working with an ad hoc consortium of designer-analysts to propose a very economical application of emerging technologies (GPS and gigahertz communications products) to give pilots a situation display in the cockpit that keeps a gray-matter CPU in the loop and the FAA out of the loop. The problem has been to get the government's sincere attention. They want to build more equipment, hire more people, and spend more money....not less!

So you see, Bob, fuzzy logic isn't really new. Clergy and politicians have practiced it for centuries. Business schools have only become infected in the past few decades. Your reference to old formulas and cookbooks gives them too much credence. The word "obsolete" implies validity in times past; many such crutches were never valid. Thank you, sir, for being a good observer, doing sound analysis upon observations and having the courage to write about it in the face of authority.

ROBERT L. NUCKOLLS III
AeroElectric Connection
Wichita, Kans.

I still think technology may help prevent certain types of aircraft collisions. But keeping your eyes peeled and your neck swiveling is still the best defense.—RAP

All for now. / Comments invited!
RAP / Robert A. Pease / Engineer

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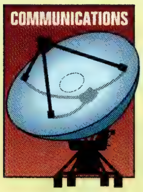

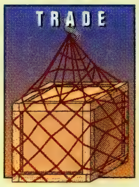

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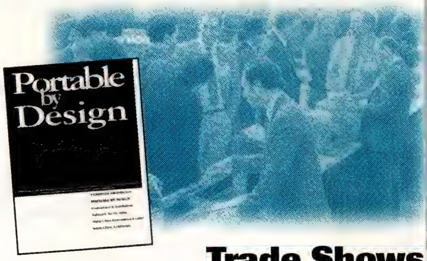

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BY RAY DULEY
Advanced Micro Devices Inc., 5204 E. Ben White Blvd., Austin, TX 78741; (512) 602-5863.

For many notebook-computer products, the power-supply design is executed almost as an afterthought as the design cycle nears completion. Once all of the other components are placed inside the enclosure, the remaining area is consigned to the power-supply designer, who must squeeze in the supply. This not only means that the power-supply board can be irregular in shape, but it also complicates power distribution and compromises the system's overall noise immunity.

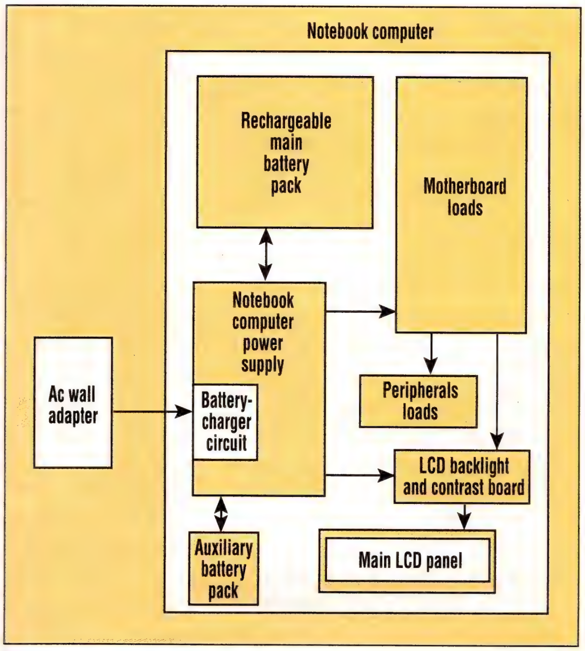
Often, the resulting product is difficult to assemble and debug and may also fail EMI testing. In addition, its overall reliability is sacrificed and costs are driven up. One way to avoid this dilemma is to get the power-supply designer involved at the front end of the design cycle rather than ask him to fix poor design choices after the design is well underway. This article will attempt to enlighten designers on some of the do's and don'ts of notebook power-supply design.

The first task in designing notebook supplies is to identify the system's power requirement. Typically, the product-marketing group specifies what notebook computer is required to meet the customers' needs and then generates a Marketing Requirement Document. The design group evaluates this document and tentatively selects both the ICs and peripherals that will fit into the enclosure.

Engineering follows up with a suite of analyses on space, power, and cost. Space analysis is done to determine the total area required by the main-processor board, power-supply board, and daughterboards. Next, a space analysis assesses whether all notebook computer modules (hard drives, batteries, floppy, modem, and so on) will fit into the enclosure. The many trade-offs involved in placing peripherals and components make this a time-consuming task. These trade-offs include power distribution, data buses, cables, location and type of connectors, input filters, user-accessible modules (such as removable hard drives), and cost.

Finally, a power-budget spreadsheet is used to calculate the average and peak power required for the different power-management states. The power-budget spreadsheet takes into account all of the electrical components contained within the system. It's desirable to group similar components into functional categories *(Table 1)*. Then, a certain sequence of steps should be followed to set up each cell of the spreadsheet *(Table 2)*. The cells contain either data or equations that allow the spreadsheet to automatically calculate battery life. The designer can have the spreadsheet recalculate the new battery life by changing one or more cells. That is, he can add or subtract electrical components, change their on-to-off time ratios, substitute a different battery pack, or whatever else.

The input energy for the power supply comes from one of three sources: a main battery pack, an auxiliary battery pack (optional), or an ac adapter *(Fig. 1)*. The power supply drives the motherboard, peripherals, backlight/contrast board, and battery-charger circuit. For each power-management state, all of the maximum and nominal loads are specified. These loads can change from 3 A in the full-



1. The input energy for the power supply comes from one of three sources: a main battery pack, an auxiliary battery pack (optional), or an ac adapter. The power supply drives the motherboard, peripherals, backlight/contrast board, and battery-charger circuit.

TABLE 1: A NOTEBOOK'S POWER CONSUMERS

Main category	Sub-category
Motherboard circuits	
CPU subsystem	Core logic, system memory, flash memory (BIOS), power-management controller
Keyboard subsystem	Keyboard controller; keyboard; trackball; Num, Caps Lock, Scroll Lock indicator board
Video subsystem	Video controller, video memory
Super-I/O subsystem	Super-I/O controller, RS-232 transceiver, IDE buffers, EMI filters, and so on
Floppy-disk subsystem	Floppy-disk controller
PCMCIA subsystem	PCMCIA controller and support circuitry
Business audio subsystem	Audio controller, interface electronics to speaker/microphone
Docking-station subsystem	Transceiver circuits, controller, miscellaneous circuits
Peripheral devices	
Hard drive (IDE)	
LCD panel	
Floppy disk	
PCMCIA cards	Fax/modems (wired/wireless), memory cards (flash, DRAM, ROM, SRAM), cellular phone, SCSI adapter, PCMCIA hard drive, LAN adapters (wired/wireless), and so on
Power-supply inefficiencies	
Main regulators	+5 V, +3.3 V, +12 V p-p
LCD-panel support	Contrast voltage, contrast control circuit, backlight inverter (dc-ac regulator), backlight control circuit
Battery pack	Technology (NiMH, lithium ion), capacity (watt-hours)

speed state to less than 0.003 A in the suspended state, or 100,000%. The power supply must dynamically switch various regulators into the circuits to maintain high efficiency (that is, over 85%) over these vastly different load conditions. Switching regulators are required to drive heavier loads (full-speed operation), while gated oscillators or linear regulators handle lighter loads (standby or suspend).

In most cases, the main battery pack is the heaviest module in a notebook computer. The specifications for the battery pack include the pack's watt-hour rating and the type, size, and number of cells. Accessory circuitry typically includes a thermistor to detect the pack's internal temperature, a poly switch (an electronic circuit breaker to prevent excess current levels), and a pc board with a charge gauge *(Fig. 2)*.

The main battery pack must deliver a maximum voltage of 1.6 V/cell times the number of cells. If we assume a pack of ten cells, this works out to 16 V. The minimum voltage must be 0.9 V per cell, or 9 V for a 10-cell pack. Its maximum current must be enough for full-power-on.

An auxiliary battery pack of six cells must provide the minimum input voltage for the supply's regulators plus 1.2 V. For six cells, that would be 1.2 V per cell or 7.2 V.

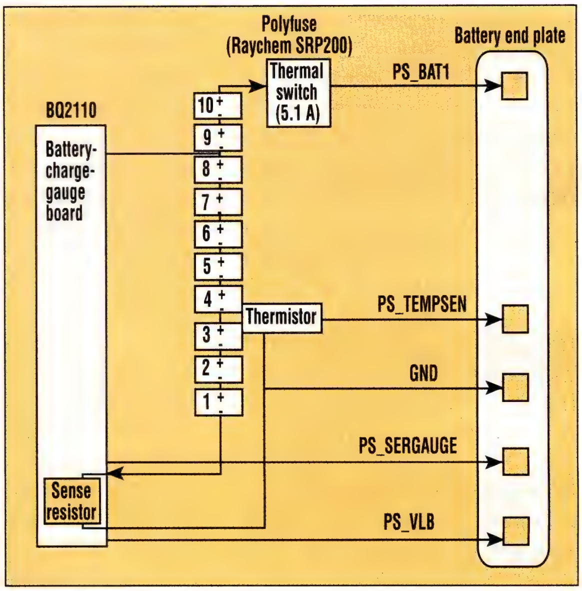
Nickel-metal-hydride (NiMH) cells are replacing nickel-cadmium (NiCd) batteries, and for good reason. NiMH cells have greater capacity (in some cases, over 25% more) than NiCd types and exhibit no memory effect. That is, NiMH cells won't lose capacity if shallow discharge cycles are used. In addition, NiMH cells are environmentally friendly and are becoming competitive cost-wise.

The battery pack must be carefully constructed to ensure that the pack not only allows current to flow through large conductors, but that it also spot-welds cell straps to create low-resistance contacts. The thermistor must be located near the middle of the pack and insulated from the outside so that it senses the case temperature and not the ambient air around the pack. The poly switch should be wired in series with the battery cells. This device will allow current to flow up to its current limit, which might be 5 A. If this current limit is exceeded, then the poly switch will open and protect the battery cells. When the short is removed, the poly switch will return to its low-impedance state.

Some common problems are known to occur in battery-subsystem design. Often, the battery contacts don't align with the battery clips, the clips don't press firmly against the pack's contacts, and/or the battery contact/clips oxidize. Most notebook manufacturers have redesigned their battery clips several times to increase the reliability of these connections. Today's packs use connectors rather than battery contacts and battery clips. Such connectors align themselves by using two wiper blades per contact to trap each battery pin (such as Duracell's NiMH battery pack DR30 with the advanced interconnect connector). A wiping contact is important, because resistance of more than 0.2 Ω on battery connections can impose more than 200 mV of noise on incoming power. Such a connector maintains low resistance and is a very reliable contact even if the portable product is subjected to vibration.

Another mistake is to elimi-

2. In most cases, the main battery pack is the heaviest module in a notebook computer. The pack's specs include its watt-hour rating and the type, size, and number of cells. Accessory circuitry typically includes a thermistor to detect the pack's internal temperature, a poly switch (an electronic circuit breaker to prevent excess current levels), and a pc board with a charge gauge.



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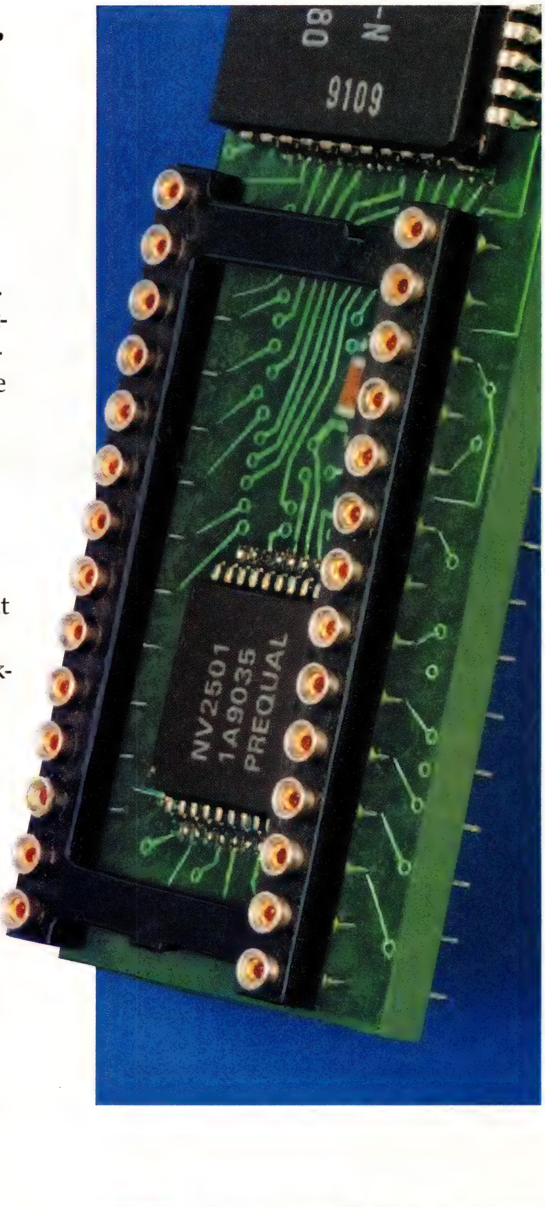

THE PROBLEM:

"We had a bunch of new designs but couldn't get the ICs we needed. Some had excruciating lead times. Some thru-hole parts were obsoleted by surface mount devices. We had new designs plus a huge inventory of existing boards. But we couldn't produce any of them because we couldn't get the right devices.

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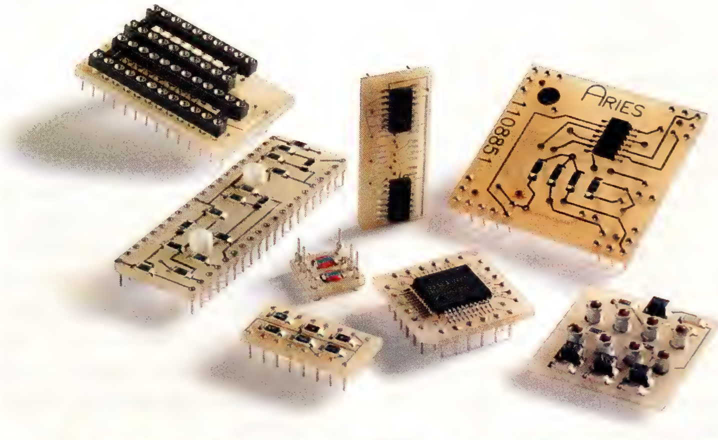

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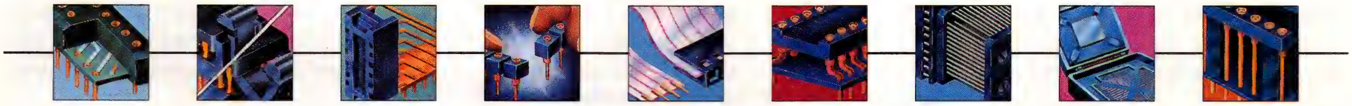

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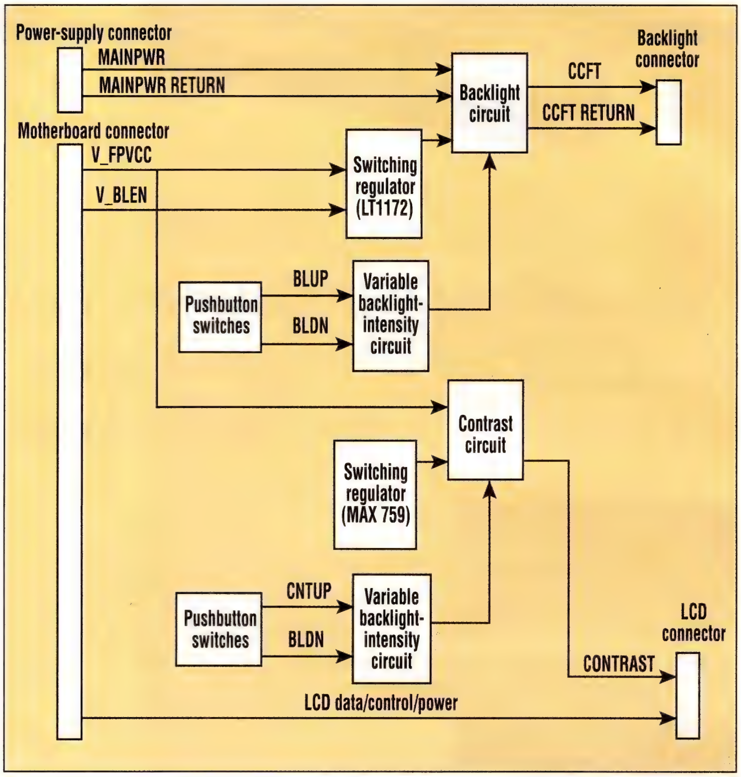
nate the battery-charge detector board from the battery pack in an effort to reduce the pack's cost. Circuit designers have tried to use voltage comparators to determine battery-charge levels. Not only is this method inaccurate, but it may even harm the battery pack. The curves for charge and discharge versus time for a given battery pack are very nonlinear and change as a function of a particular variable, such as temperature, discharge rates, depth of discharge, the cells' ages, and so on. If the battery pack is overcharged (more than 1.6 V/cell) or deep-discharged (less than 1.0 V/cell), then its useful life will be reduced. It's critical, therefore, that these parameters are sensed accurately. These limits, by the way, apply to both nickel cadmium and nickel metal hydride batteries.



3. Using a switching-regulator IC, such as LTC's LT1172, in the variable-intensity backlight inverter circuit is beneficial in controlling the current through the backlight tubes rather than the voltage. This allows uniform control while also increasing efficiency.

A key element in the power-supply system of a notebook is its ac wall adapter. These devices are ac-to-dc switching regulator converters that plug into the ac wall receptacle to power the notebook computer and charge the battery packs. Two types of switching regulators should be considered for a new design that uses both discrete and surface-mounted components. The trend in adapter design, as in just about everything else, is to reduce both weight and size for the sake of portability.

Assuming a ten-cell battery pack, the ac wall adapter must be able to deliver the maximum charge voltage plus enough to make up for the drops across the connectors and series-pass transistors. For example, this would be 16 V plus 3 V for a total of 19 V ±5% measured at the output connector. The maximum current should be the pack's charge limit of 1.8 A.

On the input side of the wall adapter, two types of protection must be designed in: an EMI filter and a reverse-polarity circuit. The EMI filter must be located as close to the input connector as possible (less than 0.25 in.). A series ferrite bead attenuates high-frequency EMI noise induced on the adapter's output cable. The filter also includes parallel bypass ceramic capacitors that give high-frequency noise a low-impedance path away from the power supply. These capacitors should be placed on the power-supply board with leads as short as possible to minimize their inductance.

At the computer end, an input-protection circuit should consist of the following: a Zener to clamp overvoltage conditions, a diode to protect against reverse polarity, and a fuse to protect against overcurrent conditions. Such a circuit anticipates the inevitable attempts by end users to plug in a wall adapter, which reverses the polarity on the ac wall-adapter jack or provides too much voltage or current.

On the adapter's output, its dc-voltage specification must be equal to the total number of cells times the maximum charge voltage (1.6 V/cell) plus a few extra volts to compensate for series drops in the charge path. For example, the voltage required for a 10-cell battery pack is:

$$10 \text{ cells} \times 1.6 \text{ V/cell} + 3 \text{ V} = 19 \text{ V}$$

The adapter's current limit is specified to match the watt-hour rating of the main battery pack and the time required to charge it. The greater the batteries' watt-hour rating, the larger the adapter's power rating must be for the pack to be charged in one hour. For a 15-Wh battery pack, the adapter's current limit would be:

$$15 \text{ Wh}/(10 \times 1.2 \text{ V/cell}) = 1.25 \text{ Ah}$$

The adapter's current limit should be matched to the battery capacity. Also, it's important that current-limit regulation be located in the adapter rather than in the notebook power supply. That will hold down the supply's size and weight and limit the heat it generates within the system.

Once we know the system's power budget and estimated battery life, evaluated the options

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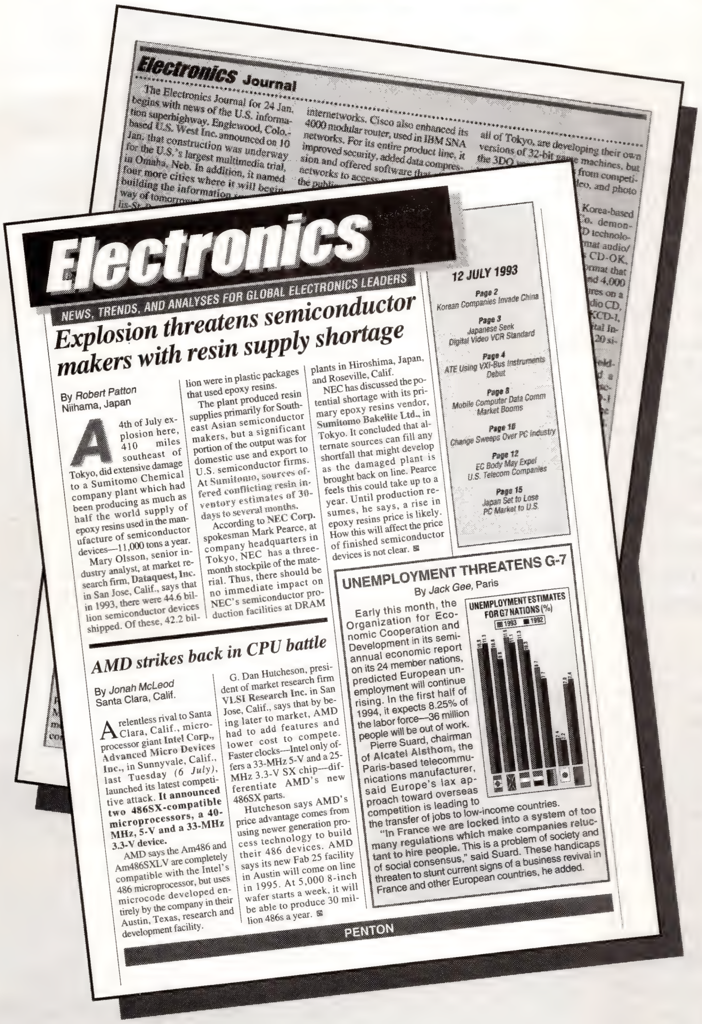

Electronics Journal

The Electronics Journal for 24 Jan.
begins with news of the U.S. informa-
tion superhighway. Englewood, Colo.-
based U.S. West Inc. announced on 10
Jan. that construction was underway
for the U.S.'s largest multimedia trial,
in Omaha, Neb. In addition, it named
four more cities where it will begin
building the information

internetworks. Cisco also enhanced its
4000 modular router, used in IBM SNA
networks. For its entire product line, it
improved security, added data compres-
sion and offered software that

all of Tokyo, are developing their own
versions of 32-bit game machines, but

Electronics

NEWS, TRENDS, AND ANALYSES FOR GLOBAL ELECTRONICS LEADERS

12 JULY 1993

Page 2 Korean Companies Invade China
Page 3 Japanese Seek Digital Video VCR Standard
Page 4 ATE Using VXI-Bus Instruments Debut
Page 8 Mobile Computer Data Comm Market Booms
Page 10 Change Sweeps Over PC Industry
Page 12 EC Body May Expel U.S. Telecom Companies
Page 15 Japan Set to Lose PC Market to U.S.

Explosion threatens semiconductor makers with resin supply shortage

By *Robert Patton*
Niihama, Japan

A 4th of July explosion here, 410 miles southeast of Tokyo, did extensive damage to a Sumitomo Chemical company plant which had been producing as much as half the world supply of epoxy resins used in the manufacture of semiconductor devices—11,000 tons a year.

Mary Olsson, senior industry analyst, at market research firm, **Dataquest, Inc.** in San Jose, Calif., says that in 1993, there were 44.6 billion semiconductor devices shipped. Of these, 42.2 billion were in plastic packages that used epoxy resins.

The plant produced resin supplies primarily for Southeast Asian semiconductor makers, but a significant portion of the output was for domestic use and export to U.S. semiconductor firms. At Sumitomo, sources offered conflicting resin inventory estimates of 30-days to several months.

According to **NEC Corp.** spokesman Mark Pearce, at company headquarters in Tokyo, NEC has a three-month stockpile of the material. Thus, there should be no immediate impact on NEC's semiconductor production facilities at DRAM plants in Hiroshima, Japan, and Roseville, Calif.

NEC has discussed the potential shortage with its primary epoxy resins vendor, **Sumitomo Bakelite Ltd.**, in Tokyo. It concluded that alternate sources can fill any shortfall that might develop as the damaged plant is brought back on line. Pearce feels this could take up to a year. Until production resumes, he says, a rise in epoxy resins price is likely. How this will affect the price of finished semiconductor devices is not clear. ▣

AMD strikes back in CPU battle

By *Jonah McLeod*
Santa Clara, Calif.

A relentless rival to Santa Clara, Calif., microprocessor giant **Intel Corp.**, **Advanced Micro Devices Inc.**, in Sunnyvale, Calif., last Tuesday *(6 July)*, launched its latest competitive attack. **It announced two 486SX-compatible microprocessors, a 40-MHz, 5-V and a 33-MHz 3.3-V device.**

AMD says the Am486 and Am486SXLV are completely compatible with the Intel's 486 microprocessor, but uses microcode developed entirely by the company in their Austin, Texas, research and development facility.

G. Dan Hutcheson, president of market research firm **VLSI Research Inc.** in San Jose, Calif., says that by being later to market, AMD had to add features and lower cost to compete. Faster clocks—Intel only offers a 33-MHz 5-V and a 25-MHz 3.3-V SX chip—differentiate AMD's new 486SX parts.

Hutcheson says AMD's price advantage comes from using newer generation process technology to build their 486 devices. AMD says its new Fab 25 facility in Austin will come on line in 1995. At 5,000 8-inch wafer starts a week, it will be able to produce 30 million 486s a year. ▣

UNEMPLOYMENT THREATENS G-7

By *Jack Gee*, Paris

Early this month, the Organization for Economic Cooperation and Development in its semiannual economic report on its 24 member nations, predicted European unemployment will continue rising. In the first half of 1994, it expects 8.25% of the labor force—36 million people will be out of work.

Pierre Suard, chairman of Alcatel Alsthom, the Paris-based telecommunications manufacturer, said Europe's lax approach toward overseas competition is leading to the transfer of jobs to low-income countries.

"In France we are locked into a system of too many regulations which make companies reluctant to hire people. This is a problem of society and of social consensus," said Suard. These handicaps threaten to stunt current signs of a business revival in France and other European countries, he added.

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for power-regulation circuits, and estimated the power supply's volume, we can write a functional product specification (FPS) for the supply. The FPS sets forth the power voltages, power requirements, tolerances, and the control and sense signals between the supply and its controlling logic. This document also contains the detailed top-level block diagram that shows how the major dc-dc and dc-ac converters, battery charger, and control signals will interface with the supply. Consequently, digital designers will be able to understand the link between the power supply and the digital logic. The FPS also includes a pinout table that specifies the names of interconnect signals and describes their active states.

Now let's examine some of the major components and functions of the power supply. One important element is standby regulators, which are required because the main dc-dc regulators have poor efficiency below 100 mA. In the past, the designer electronically switched in linear regulators (such as the LM2931CD) once the logic informed the supply that the user wanted to enter the standby or suspend modes. The newer switching-regulator circuits (such as the MAX782) sense the load current and automatically switch in the regulator that will have the highest efficiency. These standby regulators are either gated-oscillator switching regulators or linear regulators, depending on the IC solution.

The dc-ac high-voltage inverter circuit powers the LCD backlight. The backlight consists of either one or two cold-cathode fluorescent tubes (CCFTs). These highly nonlinear tubes require from 1000 to 1500 V ac to ignite. Once the tube is ignited, however, its impedance decreases to less than a third of its initial value. The operating voltage is typically 320 V ac and can be adjusted with the front-panel backlight-intensity control, which consists of either a potentiometer or two switches. The backlight circuit uses the intensity control as an input and varies the power delivered to the lamp.

LCD manufacturers specify backlight inverters that are compatible with their lamps. Such circuits are typically specified with either +5 or +12-V inputs (±5%). The designer can use either a linear or pulse-modulated regulator to vary the voltage around the nominal value to produce a very limited intensity control. A better solution is to employ an IC, such as Linear Technology's LT1172, for the variable-intensity backlight inverter circuit. This circuit uses the backlight intensity circuit via the E^{2}POTs (Xicor's X9C103 digital potentiometers) as an input and controls the current through the CCFT tubes. Controlling the current rather than the voltage allows uniform control range of the CCFT lamps. The circuit also increases efficiency from 70% to as high as 85% *(Fig. 3)*. With higher efficiency, the battery life is greatly improved because the backlight consumes more power than any other peripheral.

It's the efficiency of the power regulators that separates machines with short battery life from those with long battery life.

TABLE 2: CALCULATING BATTERY LIFE FROM A POWER SPREADSHEET

1. Identify the major components (such as CPU, memory, core logic, VGA controller, super-I/O controller, PCMCIA controller, and so on).
2. Group the components into functional categories (such as video subsystem).
3. Obtain the components' power consumption from their manufacturers' data sheets.
4. Obtain the peripherals' power consumption from data sheets per power states (for example, IDE supports several power-management states).
5. Calculate or arrive at assumptions of the percentages of on and off time for each component for all power-management states.
6. Calculate or specify power-supply efficiencies for each power-management state.
7. Specify the battery pack (type, number, and capacity of cells).
8. Calculate the battery pack's capacity.
9. Calculate power consumption using the percentage of time for each power-management state.
10. Summarize the power consumption on a summary sheet.
11. Calculate battery life by dividing battery capacity by power consumption per state.
12. Calculate battery life by multiplying the power consumption per state by the amount of time spent in each state.
13. Summarize all assumptions made in the battery-life calculations on the summary sheet.

The switching regulator within the LCD-contrast circuit generates a voltage that falls between either –13 to –22 V or +26 to +38 V *(Fig. 3, again)*. In a switching-regulator circuit, it's critical that components such as the switching-regulator IC, the reservoir input capacitor, the output storage capacitor, the switching transistor, and the switching diode be placed as close together as possible. It's also important to make the large switching current path as short as possible. This means every component must be side by side and oriented so as to minimize pc-trace lengths. Observing these rules increases the regulator's efficiency and reduces circuit radiation.

Many LCDs require both backlight and contrast control to optimize the contrast ratio in various ambient-light conditions. The designer might choose to use a potentiometer, such as a slide-switch control. These potentiometers can change resistance with variables such as temperature, humidity, age, and adjustment cycles. A better control is up/down switches, which can be inputs to either an E^{2}POT circuit or a microcontroller that's programmed to store these settings in nonvolatile RAM (multiplexed with the keyboard controller).

In the end, it's the efficiency of the power regulators that separates machines with short battery life from those with long battery life—assuming both have advanced power management. When reading ads for power ICs, the efficiency usually is given as the maximum efficiency with a specified input voltage and output load. Unfortunately, this efficiency can't al-

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UWR-3.3/1800-D5	3.3	1800	4.7 - 7	50	69%	500	2 x 1 x 0.375	$69
UWR-3.3/2500-D12	3.3	2500	9 - 18	50	74%	500	2 x 1 x 0.375	$69
UWR-3.3/1800-D48	3.3	1800	18 - 72	75	72%	500	2 x 1 x 0.375	$69
UWR-3.3/4250-D5	3.3	4250	4.6 - 13.2	75	72%	500	2 x 2 x 0.45	$79
UWR-3.3/4850-D12	3.3	4850	9 - 36	75	74%	500	2 x 2 x 0.45	$79
UWR-3.3/4850-D48	3.3	4850	18 - 72	100	78%	500	2 x 2 x 0.45	$79
UNR-3.3/8000-D5	3.3	8000	4.5 - 5.5	55	87%	None	2 x 1 x 0.375	$50
UNR-3.3/12000-D5	3.3	12000	4.5 - 5.5	55	85%	None	2 x 2 x 0.45	$59
UNR-2.1/8000-D5	2.1	8000	4.5 - 5.5	55	80%	None	2 x 1 x 0.375	$50
UNR-2.1/16000-D5	2.1	16000	4.5 - 5.5	55	79%	None	2 x 2 x 0.45	$59

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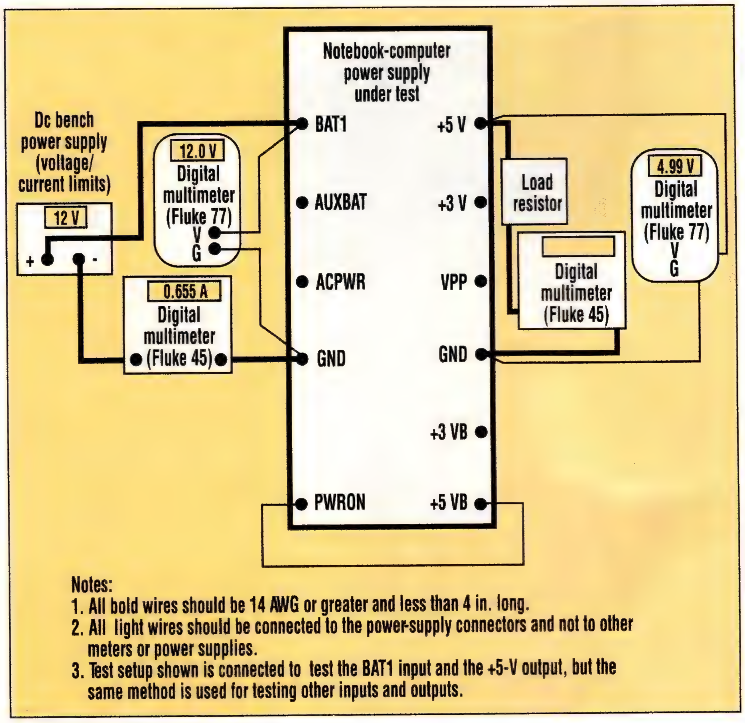
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Dc bench power supply (voltage/ current limits)
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+
-
12.0 V
Digital multimeter (Fluke 77)
V
G
0.655 A
Digital multimeter (Fluke 45)
BAT1
AUXBAT
ACPWR
GND
PWRON
+5 V
+3 V
VPP
GND
+3 VB
+5 VB
Load resistor
Digital multimeter (Fluke 45)
4.99 V
Digital multimeter (Fluke 77)
V
G

Notes:
1. All bold wires should be 14 AWG or greater and less than 4 in. long.
2. All light wires should be connected to the power-supply connectors and not to other meters or power supplies.
3. Test setup shown is connected to test the BAT1 input and the +5-V output, but the same method is used for testing other inputs and outputs.

4. Measuring the efficiency of regulators requires four digital multimeters. Two are used to measure input power—one for input voltage and one for input current. The other two are used to measure output power. The bold lines indicate short, low-impedance connections.

ways be obtained because notebook power supplies must operate through a wide range of input voltages. For instance, a 10-cell battery pack can vary from 16 V fully charged to 10 V fully discharged. To squeeze the greatest efficiency out of regulator circuits, all input power should reach the circuit through a low-impedance path, such as voltage and ground planes. Similarly, all output power should be supplied by low-impedance paths as well.

Measuring the efficiency of regulators requires four digital multimeters. Two are used to measure input power, one for input voltage and one for input current. The other two are used to measure output power *(Fig. 4)*. In any such setup, the current meters should have accuracy in the 0.01-A range. Note that although the test setup in the figure is connected to measure the +5-V output, the same configuration applies to the other two voltages. In addition, the bold black lines indicate short, low-impedance connections, such as 4-in., 18 AWG leads. After making those connections, use the voltmeters to go through the series current path to assure that no unexpected voltage drops occur before taking data. Then vary the load resistor and measure the input current, output current, and output voltage with different input voltages.

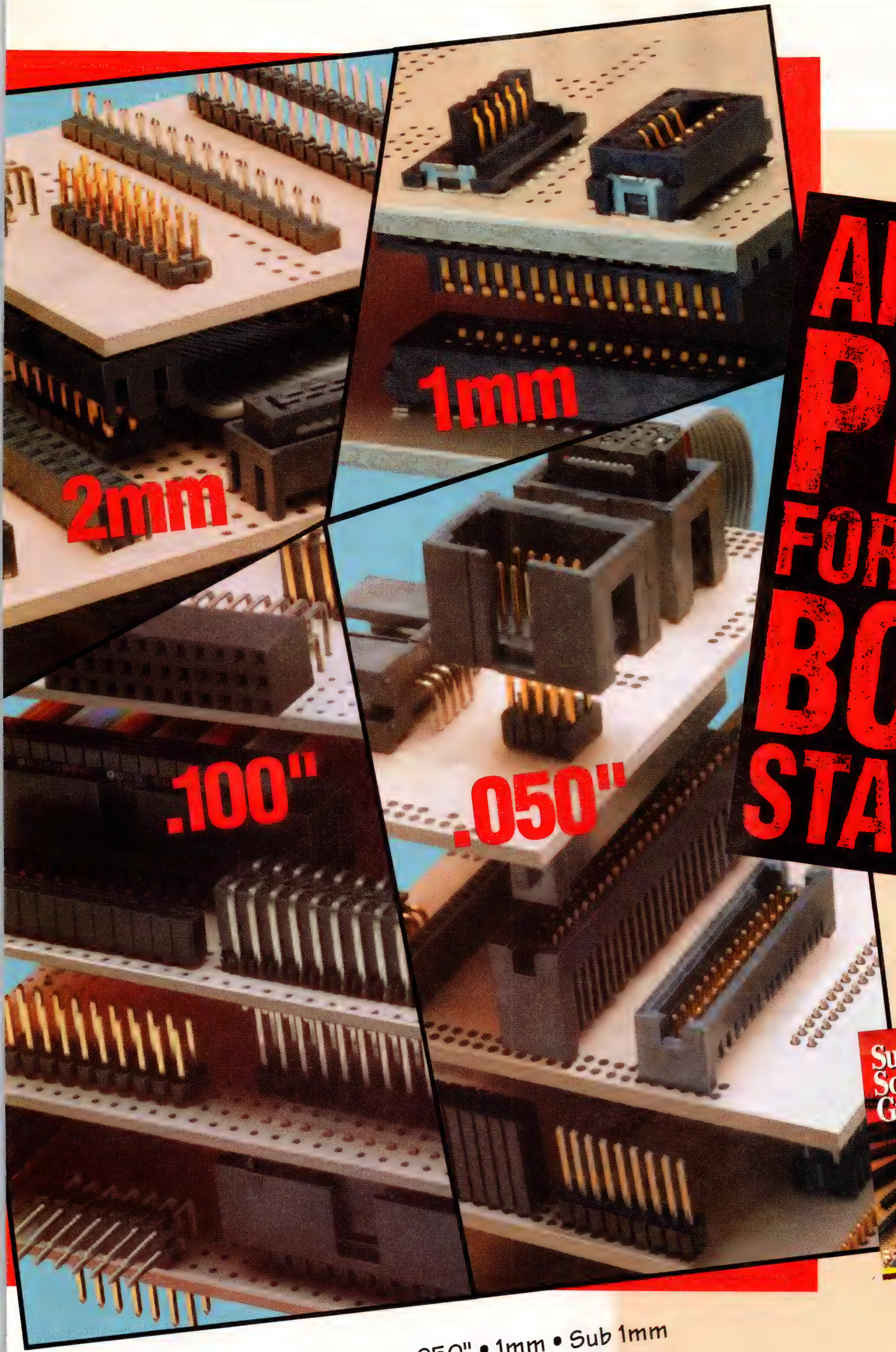
Another item to consider is the system's operating and storage temperature ranges. Both are dictated by modules in the notebook-computer case other than the power supply. An IDE drive's operating-temperature range is from +5 to +55°C (for Areal's A260 drive). For the LCD, operation is from 0 to +45°C (for Sharp's 64P80 display). Because both the drive and power supply must coexist in one enclosure, the supply should be specified as a minimum of 15° above the IDE specification. If the supply's regulators are highly efficient, there's less heat to dissipate because 80% to 90% of the energy is reaching the loads. The amount of time spent in each operating mode is important in determining the internal temperature. The more time expended for computing means higher internal temperatures.

Notebook computers must pass FCC class B EMI specifications for commercial electronic equipment. Therefore, EMI filtering must be present on the wall-adapter connector as well as all external ports. These filters consist of ferrite beads, resistor and capacitor low-pass filters, and bypass capacitors.

Several of the system's major components work together to form the battery-management subsystem *(Fig. 5)*. These include the battery pack, wall adapter, battery charger, battery-charge gauge, and recalibration circuit. Many notebook computers do a very poor job of managing the rate of battery charge and depth of discharge cycles. And to make matters worse, many end users don't completely discharge their machine's battery packs before charging them. This causes two potential problems. One, if the battery pack contains NiCd cells, there will be memory-effect problems that significantly reduce the pack's capacity. Two, the battery-charge gauge must be recalibrated to keep track of the full charge and discharge points as the battery ages.

Solving the first problem is simply a matter of using NiMH cells, which don't develop any memory effect if they're not fully discharged. Solving the second problem means adding a recalibration circuit to the power supply that allows the battery to go through a discharge cycle. This discharge cycle consists of turning off the wall adapter and operating the notebook at full speed until the battery discharges to 1 V/cell, then immediately charging the pack to 1.6 V/cell.

First-generation charger circuits applied a constant current to the battery pack until the pack voltage reached the maximum-charge value. The curves for battery charge versus time vary greatly with temperature, charge rates, and age. When the battery is fully charged, then the battery charger must be turned off or the voltage across the pack and its internal temperature will rapidly increase. Either condi-



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tion can shorten the battery life. Advanced battery-charger ICs, such as Benchmarq's BQ2003, sense parameters like ΔV versus ΔT, Δtemperature versus ΔT, and maximum-charge cell voltage. The BQ2003 chip senses the temperature using the thermistor in the battery pack, and senses the voltage by means of a remote voltage-sense line to the battery to ensure accurate detection of voltage changes.

Battery-charger ICs also should support different charge modes. In the fast-charge mode, the constant-current wall adapter is connected to the battery pack. A top-off charge occurs when the battery pack reaches 95% of full charge and the constant current is modulated on and off in half-minute increments. In trickle mode, the battery pack reaches 100% of charge and the trickle current is provided to offset the pack's internal leakage current.

The battery-charge gauge gives the user feedback as to when the computer will require recharging. In the past, designers used voltage comparators to determine what charge levels were being sensed. This poor method assumes a repeatable, linear discharge curve and also assumes that the charge level is directly proportional to sensed battery voltage. Notebook users quickly found such inaccurate gauges to be worthless. The second generation of charge gauges sensed current by means of a serial sense resistor that fed an analog-to-digital converter. While this method was an improvement, it didn't account for variables such as temperature, depth of discharge, and the age of the battery pack.

Today's battery-charge gauges use a microcontroller that includes a serial battery-pack sense resistor, remote battery-voltage sensing, temperature sensing, and digital counters. The gauge must accurately know the fully-charged and fully-discharged voltages as well as the energy that's delivered to the load as the pack moves from the former condition to the latter. Then the microcontroller accurately calculates the remaining charge.

If the charge gauge hasn't sensed a full-discharge cycle followed by a full-charge cycle for a period of time or for a number of battery-charge cycles, it sets a capacity-inaccurate flag. When the system BIOS detects this flag, it asks the user for the go-ahead to run a battery-discharge cycle. If the user grants permission to execute, the power supply disables the wall-adapter input and the machine discharges the battery. When the battery is completely discharged, the recalibration circuit senses this condition and enables the charger until the battery is fully charged. This information recalibrates the charge gauge until another recalibration cycle is requested.

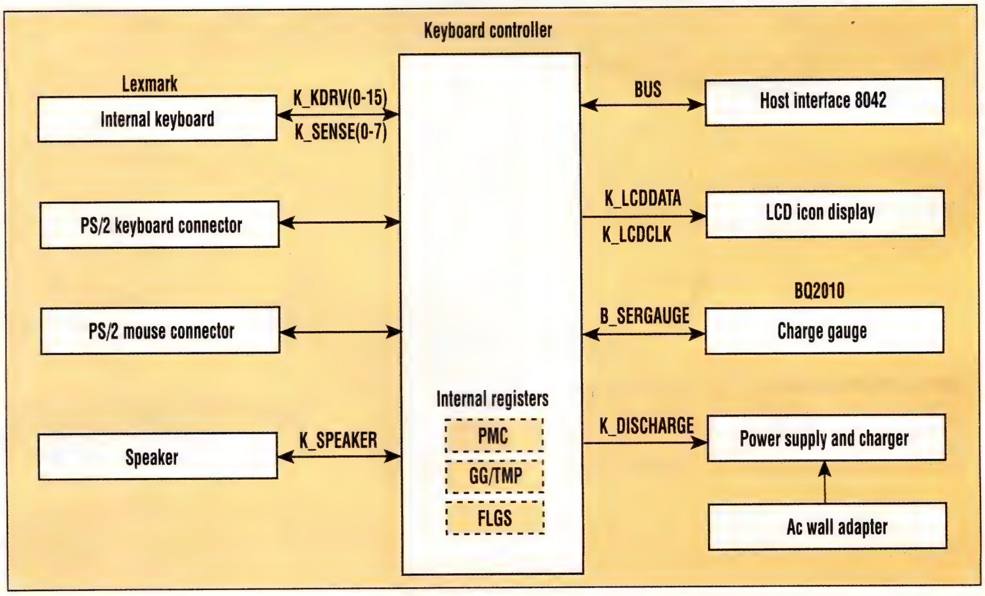
The mechanical design of a notebook computer is very important to the product's success. Typically, the best mechanical designs simplify the mechanical mounting and reduce the length of the electrical interconnect harnessing between modules. The following offers some guidelines to observe in planning the mechanical end of a notebook design.

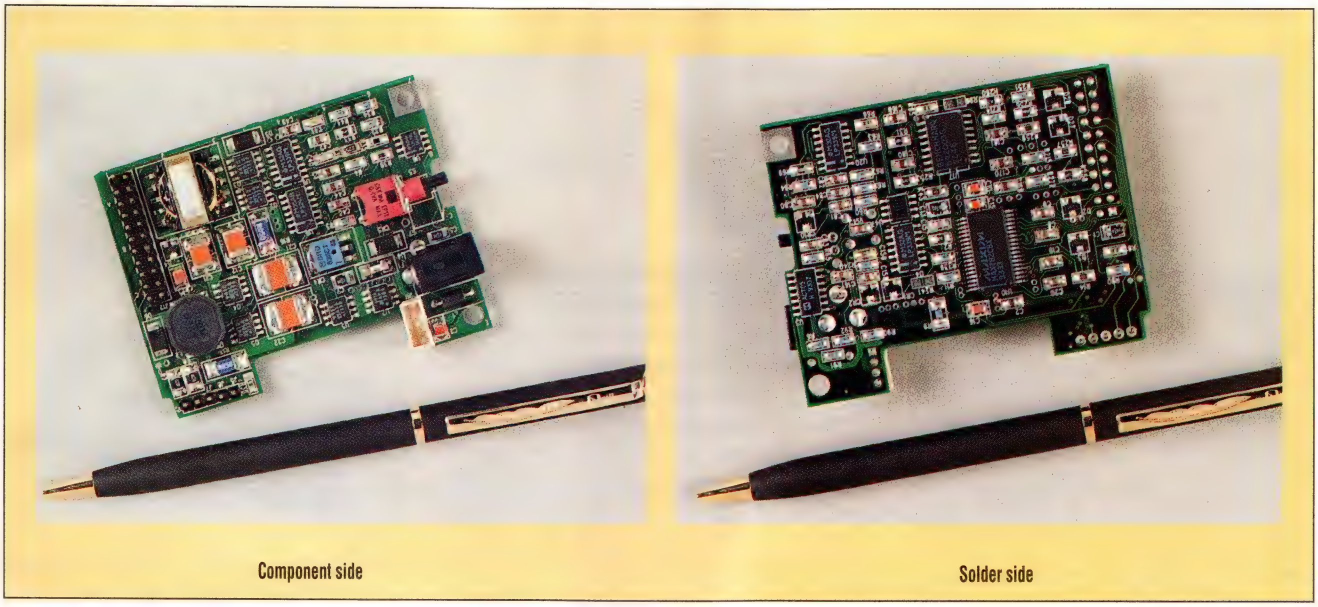
For one, the battery compartment should be designed so that the contact end of the battery pack is as close as possible to the power supply. Also, the power-supply board should be located in the area of the enclosure with the greatest amount of clearance above and below the board. Many tall components, such as inductors, transformers, storage capacitors, and connectors, are mounted to the power-supply board. The ac wall-adapter input connector should be soldered to the power-supply board and be accessible through a hole in the case.

A separate pc board should carry the LCD contrast voltage and LCD backlight inverter circuits. This board must be located close to the LCD panel, perhaps in the LCD-bezel area. In addition, the high-voltage backlight wire should be kept as short as possible and routed away from the high-voltage return wire and any metal surface for greatest efficiency.

The dc-dc regulators must be kept as close as possible to the power-supply output connector. It's best to have the regulator-circuit components positioned so that they can easily run traces as wide as 50 mils or more to the output connector. Regulator controller chips should be placed on the back side of the board under the large switching circuits whenever possible.

5. Several of the system's major components work together to form the battery-management subsystem. These include the battery pack, wall adapter, battery charger, battery-charge gauge, and recalibration circuit.





Component side

Solder side

6. An example of a state-of-the-art notebook-computer power design is AMD's Am486TM power-supply board, which is also known as the AMD Man O'War project. This four-layer board measures 2.7 in. long by 1.8 in. wide by 0.315 in. high and plugs into the Am486TM CPU notebook-computer motherboard.

Also, bypass capacitors should be placed near the V_{CC} pins of every IC.

It's important to select connectors and cables to ensure the greatest reliability. All connectors must support multiple insertions without contact failures. Don't forget to observe electrical power ratings and to ensure that modules are easily inserted into and removed from the system.

An example of a state-of-the-art notebook-computer power design is AMD's Am486TM power-supply board, which is also known as the AMD Man O'War project *(Fig. 6)*. This four-layer board measures 2.7 in. long by 1.8 in. wide by 0.315 in. high and plugs into the Am486TM CPU notebook-computer motherboard. It's populated with surface-mounted components on both sides. There are only two magnetic parts: one transformer that's 0.315 in. tall and one inductor standing 0.237 in. The wall-adapter jack is soldered directly to the board, and the jack can be accessed through a hole in the side of the case.

The supply supports three energy inputs: a main battery pack (six to ten cells), an auxiliary battery (four to six cells), and an ac wall adapter (10.2 to 19 V). It generates +5 V dc from 0 to 3 A, 3.3 V dc from 0 to 3 A, and +12 V dc from 0 to 60 mA. The larger current levels support the ready power-management state when the CPU operates at full speed; smaller current loads are used when the machine is in the standby or suspend power-management state. Even with a dynamic load, the efficiency of the regulators is greater than 85%.

A built-in battery charger supports NiMH, NiCd, and lead-acid batteries. It operates in the fast-charge, topoff, and trickle modes, and senses the three charge-terminating conditions—ΔV versus ΔT, Δtemperature versus ΔT, and maximum-charge cell voltage. The supply also supports recalibration of the charge gauge.

In addition, this supply generates the power-good signal that allows the regulated output voltages to stabilize. It then drives the signal to a true logic state after 450 ms. The power supply also supports the delayed turn-off state. This allows the microprocessor to save the state to hard disk before turning off power-management power planes.

The LCD backlight and contrast board is a four-layer type with components mounted only on the top side. The board is mounted under the LCD-bezel area and measures 4.9 in. long by 1.2 in. wide by 0.294 in. tall. Driven directly from the battery pack, the backlight circuit requires no pre-regulation because it supports input voltages from 6 to 19 V. This is important because the backlight consumes more power than any other module in the system.

The board also contains two switches that control the contrast voltage and two others that control the backlight intensity. These switches control E^2POTs which store the wiper settings for both the contrast and backlight intensity in nonvolatile RAM. The contrast has an efficiency of greater than 85% and the backlight is 87% efficient. To simplify wiring, all of the LCD control and data signals are connected to this board. These signals, with the analog contrast voltage (which is generated on this board), drive the LCD panel.

Ray Duley, a senior applications engineer at Advanced Micro Devices, received a BSEE from Ohio State University, Columbus.

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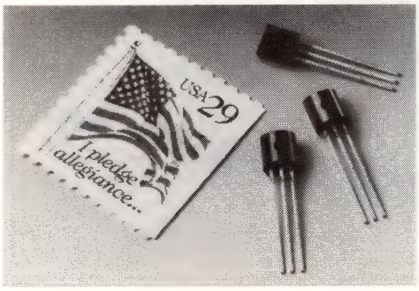

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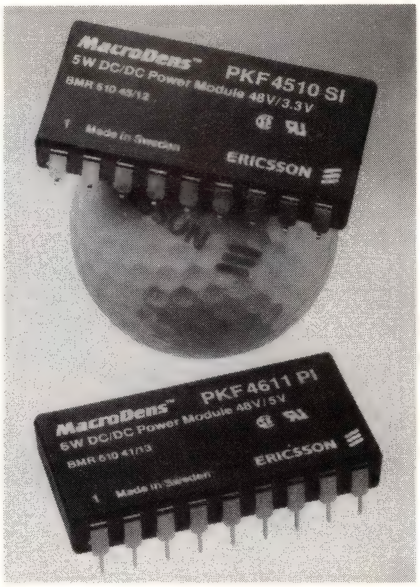

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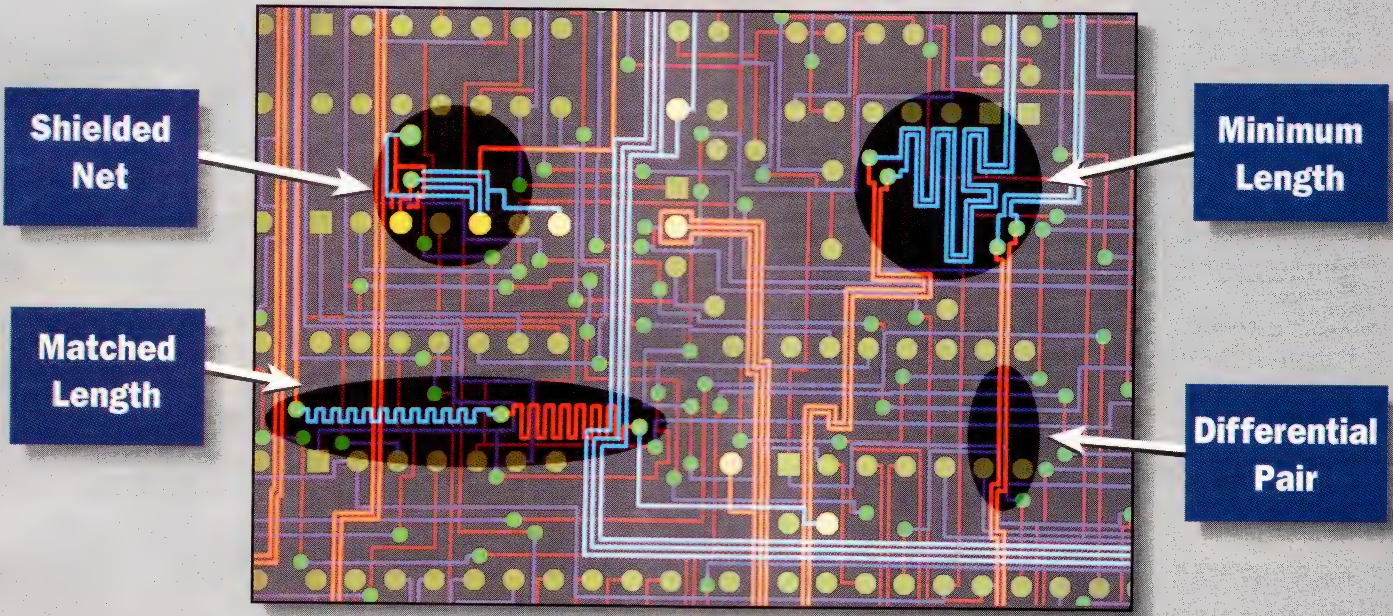

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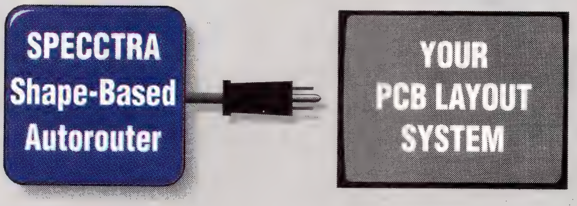

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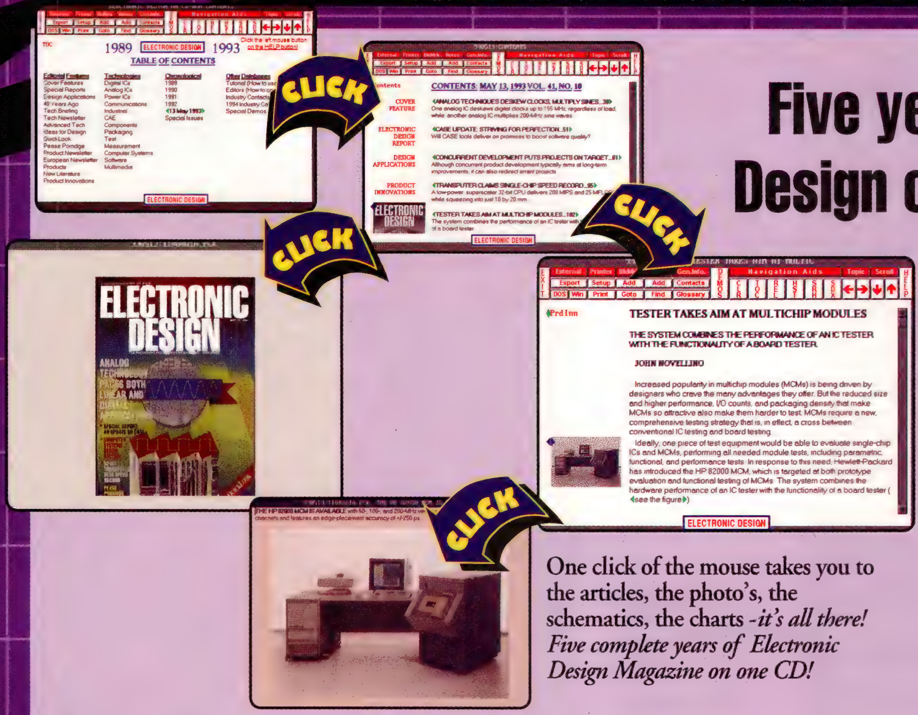

TOC

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TABLE OF CONTENTS

Editorial Features	Technologies	Chronological	Other Databases
Cover Features	Digital ICs	1989	Tutorial (How to use
Special Reports	Analog ICs	1990	Editors (How to co
Design Applications	Power ICs	1991	Industry Contacts
40 Years Ago	Communications	1992	1994 Industry Ca
Tech Briefing	Industrial	13 May 1993	Special Demos
Tech Newsletter	CAE	Special Issues	
Advanced Tech	Components		
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QuickLook	Test		
Pease Porridge	Measurement		
Product Newsletter	Computer Systems		
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Contents

CONTENTS: MAY 13, 1993 VOL. 41, NO. 10

COVER FEATURE
ANALOG TECHNIQUES DESKEW CLOCKS, MULTIPLY SINES...39
One analog IC deskews digital clocks up to 155 MHz, regardless of load, while another analog IC multiplies 200-MHz sine waves.

ELECTRONIC DESIGN REPORT
CASE UPDATE: STRIVING FOR PERFECTION...51
Will CASE tools deliver on promises to boost software quality?

DESIGN APPLICATIONS
CONCURRENT DEVELOPMENT PUTS PROJECTS ON TARGET...61
Although concurrent product development typically aims at long-term improvements, it can also redirect errant projects.

PRODUCT INNOVATIONS
TRANSPUTER CLAIMS SINGLE-CHIP SPEED RECORD...95
A low-power superscaler 32-bit CPU delivers 200 MIPS and 25 MFL while squeezing into just 10 by 20 mm.

TESTER TAKES AIM AT MULTICHIP MODULES...102
The system combines the performance of an IC tester with of a board tester.

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TESTER TAKES AIM AT MULTICHIP MODULES

THE SYSTEM COMBINES THE PERFORMANCE OF AN IC TESTER WITH THE FUNCTIONALITY OF A BOARD TESTER.

JOHN NOVELLINO

Increased popularity in multichip modules (MCMs) is being driven by designers who crave the many advantages they offer. But the reduced size and higher performance, I/O counts, and packaging density that make MCMs so attractive also make them harder to test. MCMs require a new, comprehensive testing strategy that is, in effect, a cross between conventional IC testing and board testing.

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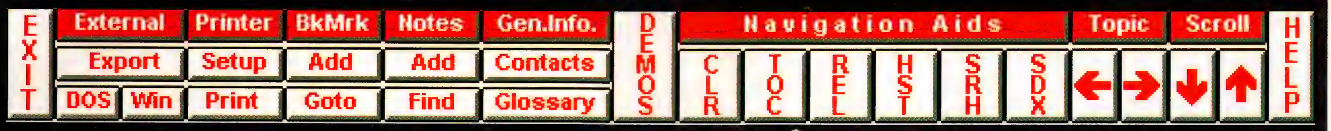

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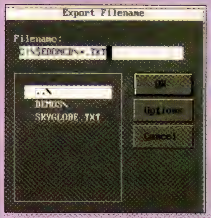
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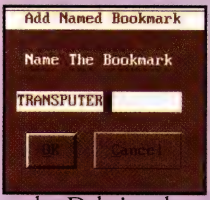
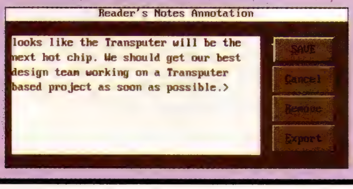
Bookmarks and Notes

BkMrk - Bookmarks flag topics for future reference, just like using a bookmark in a real magazine. Mark a spot, and the bookmark is stored even if you quit.


```
Add Named Bookmark
Name The Bookmark
TRANSPUTER
```

GOTO brings you back to your bookmarks. Deleting them is just as simple.

Notes - Add and find your own notations. Notes stay until you delete them, even after you quit.


```
Reader's Notes Annotation
looks like the Transputer will be the
next hot chip. We should get our best
design team working on a Transputer
based project as soon as possible.>
```

Gen. Info - Complete reference

Contacts - Company names, addresses, contact names, phone numbers- all of the information you need to follow up.

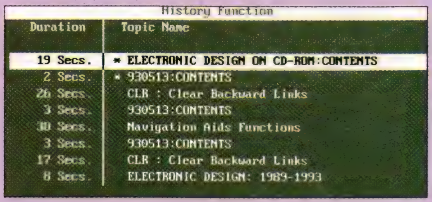
Glossary - Full article glossaries, provided by the Editors of Electronic Design magazine. The CD also comes with **WORD LINK**, which allows you to click on any word within the article and if it's in the glossary, the definition pops up. When you're done, a simple click and it's gone.

Navigation Aids - Magellan you're not, and you don't need to be!

All the aids you'll need to motor your way through this CD in no time flat.

CLR - *Clear Back Links* - Because every article you move to loads into RAM, this function allows you to clear articles you've finished. This frees up RAM for you to continue.

TOC - *Table of Contents* - Takes you directly to the Volume Table of Contents (the whole year) with special links provided to Issue T.O.C.

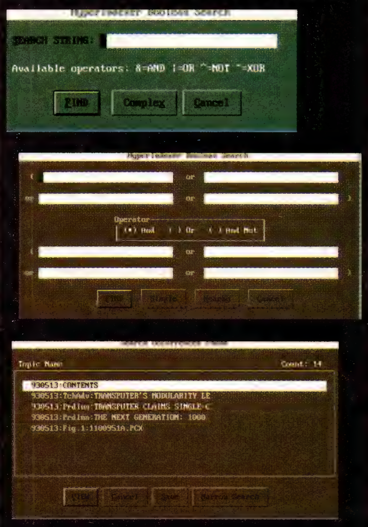

```
                History Function
  Duration   |  Topic Name

  19 Secs.   | * ELECTRONIC DESIGN ON CD-ROM:CONTENTS
   2 Secs.   | * 930513:CONTENTS
  26 Secs.   |   CLR : Clear Backward Links
   3 Secs.   |   930513:CONTENTS
  30 Secs.   |   Navigation Aids Functions
   3 Secs.   |   930513:CONTENTS
  17 Secs.   |   CLR : Clear Backward Links
   8 Secs.   |   ELECTRONIC DESIGN: 1989-1993
```

REL - *Show-Related Articles* - Calls up a list of, and lets you move to, related topics.

HST - *Show-Related History* - Shows each topic visited during your current session and how long you were there, and then lets you return to previous topics.

SEARCH dialog boxes

Simple search (top), Complex Search (center), and Search occurances found (bottom).


```
SEARCH STRING:
Available operators: &=AND |=OR ^=NOT ~=XOR
```

```
( [          ] or [          ]
or [          ] or [          ] )
Operator
(*) And   ( ) Or   ( ) And Not
( [          ] or [          ]
or [          ] or [          ] )
```

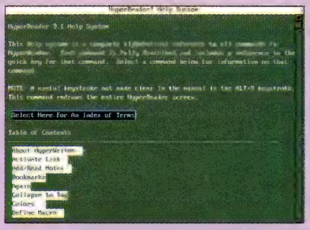
```
Topic Name                                Count: 14
930513:CONTENTS
930513:TchAdv:TRANSPUTER'S MODULARITY LE
930513:PrdInn:TRANSPUTER CLAIMS SINGLE-C
930513:PrdInn:THE NEXT GENERATION: 1000
930513:Fig.1:1100951A.PCX
```

SRH - *Search* - Conduct simple, complex or proximity indexed searches.

SDX - *Subject Index* - A hierarchical list of key subject areas compiled by the Editors of Electronic Design. The index also allows direct access to related topics.

HELP - Instant on-line help for all

Written in plain, easy to understand terms providing information for novice and pro alike. Available in any user screen.

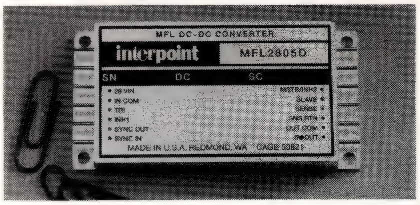

```
Select Here For An Index of Terms
Table of Contents
About HyperWriter
Activate Link
Add/Read Notes
Bookmarks
Again
Collapse to
Colors
Define Macro
```

MINIMUM SYSTEM REQUIREMENTS

- ☞ 80386 PC or better
- ☞ VGA video card adaptor w/640 x 480 pixel resolution 16 colors.
- ☞ 1 meg ram
- ☞ MS-DOS Version 3.1 or later

▼ CONVERTER PROVIDES TWO REGULATED OUTPUTS

Two independently regulated voltages of +5 and –5 V dc are derived from a 28-V input bus by the MFL2805D dc-dc converter. The unit's combination of output voltages allows the military or aerospace system designer to control complex circuits, including analog applications and ECL, TTL, or CMOS logic, with a single power supply. Without the –5-V output, the designer must turn to an additional power supply to drive these circuits. The MFL converters use the company's Asymmetrical Power Transfer technology to provide up to 50 W of output power in a welded metal case measuring 1.5 by 3 by 0.385 in. and weighing 100 grams. Prices start at $823 in lots of 100 with delivery in eight weeks.



Interpoint Corp.
10301 Willows Rd.
P.O. Box 97005
Redmond, WA 98073-9705
(206) 882-3100
▶**CIRCLE 603**

▼ BATTERY SYSTEM EXTENDS UPS'S LIFE

With the addition of its Extended Battery System (EBS), an emergency power-cabinet configuration, Upsonic's uninterruptible power supplies now offer unlimited back-up time in mission-critical applications. The EBS connects to the System models of true on-line, double-conversion UPSs, which provide from 12 to 20 minutes of back-up power to midrange computers, network nodes, workstations, and PCs. By daisy-chaining any number of EBS cabinets, the UPSs can be extended to any length of back-up time desired. The EBS fully recharges in eight hours, no matter how many units are involved. Single EBS cabinets are priced at $1600.

Upsonic Inc.
29 Journey
Aliso Viejo, CA 92656
(800) 877-6642
▶**CIRCLE 604**

POWER-SOURCE MANUFACTURERS

BICC-VERO Electronics Inc.
11000 Sherman Ave.
Hamden, CT 06514
(203) 288-8001
(51S) (500S) (200S)
(RM) (UN)
CIRCLE 724

Basler Electric Co.
Electronic Product Group
Route 143, P.O. Box 269
Highland, IL 62249
(618) 654-2341
(50S) (200S) (RM) (OF) (PF)
CIRCLE 725

Battery Engineering Inc.
1636 Hyde Park Ave.
Hyde Park, MA 02136
(617) 361-7555
(LT)
CIRCLE 726

Behlman
6 Nevada Dr.
Lake Success, NY 11042
(516) 328-1600
(50S) (51S) (11S) (200S) (LA)
(RM) (CV) (PR) (RP) (MD)
(UN) (PF) (50R) (51R) (11R)
(200R) (LI) (SW) (ML)
CIRCLE 727

Bertan High Voltage
121 New South Rd.
Hicksville, NY 11801
(516) 433-3110
(51S) (500S) (10S) (11S)
(200S) (LA) (RM) (OF) (CV)
(RP) (51C) (500C) (10C)
(11C) (DC) (MO)
CIRCLE 728

Boeing Defense
& Space Group
Electronic Systems Div.
P.O. Box 3999, M/S 3F-96
Seattle, WA 98124-2499
(206) 657-4133
(50S) (51S) (RM) (CV) (MD)
(PF) (50C) (51C) (10C) (11C)
(200C) (DC) (MO) (MI) (50R)
(51R) (10R) (11R) (200R) (LI)
(SW) (MU) (ML)
CIRCLE 729

Brandt Electronics Inc.
815 E. Middlefield Rd.
Mountain View, CA 94043
(415) 967-4944
(50S) (51S) (500S) (10S)
(11S) (200S) (CV) (MD) (PF)
(50C) (51C) (500C) (10C)
(11C) (200C) (DC) (MI) (50R)
(51R) (500R) (10R) (11R)
(200R) (LI) (SW) (ML)
CIRCLE 730

Cal-Tek Engineering
DC UPS Div.
P.O. Box 202
Kingston, MA 02364
(617) 585-5666
(50S) (11S) (RM) (UN)
CIRCLE 731

Calex Mfg. Co. Inc.
2401 Stanwell Dr.
Concord, CA 94520-4841
(510) 687-4411
(50S) (10S) (LA) (CV) (50C)
(10C) (11C) (DC) (MO)
CIRCLE 732

California Instruments Corp.
9025 Balboa Ave.
San Diego, CA 92123-1509
(800) 422-7693
(50S) (51S) (11S) (200S) (LA)
(RM) (OF) (CV) (PR) (RP)
(MD) (PF) (50C) (51C) (11C)
(200C) (MO) (50R) (51R)
(11R) (200R) (LI) (SW)
CIRCLE 733

Caritronics Inc.
P.O. Box 821
West Caldwell, NJ 07007
(201) 575-8916
(50C) (51C) (500C)
(10C) (11C) (DC)
CIRCLE 734

Central Semiconductor
Corp.
145 Adams Ave.
Hauppauge, NY 11788
(516) 435-1110
(BT) (MF) (RE) (TH)
CIRCLE 735

Cherokee International Inc.
2841 Dow Ave.
Tustin, CA 92680
(714) 544-6665
(50S) (RM) (OF) (CV) (PF)
(50C) (11C) (200C) (DC)
(MO) (SW) (MU)
CIRCLE 736

Cherry Semiconductor
Corp.
2000 S. County Trail
East Greenwich, RI 02818
(401) 886-3895
(50R) (LI) (SW) (PC)
CIRCLE 737

Christie Electric Corp.
18120 S. Broadway
Gardena, CA 90248
(310) 715-1402
(50S) (200S) (LA) (CV) (MD)
CIRCLE 738

Clary Corp.
1960 S. Walker Ave.
Monrovia, CA 91016
(800) 442-5279
(51S) (10S) (11S) (200S) (LA)
(RM) (OF) (PR) (MD) (UN)
(PF) (51C) (11C) (200C) (AC)
(MO) (MI) (51R) (10R) (11R)
(200R) (SW) (ML) (LC) (MF)
CIRCLE 739

Computer Products Inc.
Power Conversion America
7 Elkins St.
Boston, MA 02127
(617) 464-6656
(50S) (51S) (10S) (11S)
(200S) (OF) (CV) (RP) (PF)
(50C) (51C) (10C) (11C)
(200C) (DC) (MO) (IC)
(50R) (10R) (11R) (200R)
(LI) (SW) (MU) (ID)
CIRCLE 740

Contact East Inc.
335 Willow St.
North Andover, MA 01845
(508) 682-2000
(50S) (LA) (RM) (CV) (UN)
(LI) (SW) (AL) (LT) (ME) (NC)
CIRCLE 741

Controlled Power Co.
1955 Stephenson Hwy.
Troy, MI 48083
(800) 521-4792
(51S) (500S) (200S) (LA)
(RM) (CV) (PR) (MD) (UN)
(PF) (51C) (200C) (DC)
(AC) (MO) (MI) (51R)
(500R) (200R)
CIRCLE 742

Conversion Devices Inc.
15 Jonathan Dr.
Brockton, MA 02401
(508) 559-0880
(50S) (10S) (11S) (MD)
(50C) (10C) (11C) (DC)
(MO) (IC) (MI)
CIRCLE 743

Crydom Co.
6015 Obispo Ave.
Long Beach, CA 90805
(310) 865-3536
(RE) (TH)
CIRCLE 744

Custom Power Systems
33 Comac Loop
Ronkonkoma, NY 11779
(516) 467-5328
(50S) (51S) (10S) (11S)
(200S) (LA) (RM) (OF)
(CV) (RP) (MD) (UN) (PF)
(50C) (51C) (10C) (11C)
(200C) (DC) (AC) (MO) (IC)
(MI) (50R) (51R) (10R)
(11R) (200R) (LI) (SW)
(MU) (ID) (ML)
CIRCLE 745

D&B Power Inc.
204 N. Fehr Way
Bayshore, NY 11706
(516) 586-5955
(50S) (11S) (OF) (CV) (MD)
(50C) (11C) (50R) (11R) (LI)
CIRCLE 746

Datel Inc.
11 Cabot Blvd.
Mansfield, MA 02172
(508) 339-3000
(50C) (DC) (MO)
CIRCLE 747

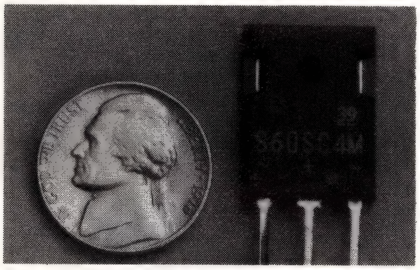
Del Electronics Corp.
Power Conversion Div.
One Commerce Park
Valhalla, NY 10595
(914) 686-3600
(500S) (10S) (11S) (200S)
(LA) (RM) (CV) (RP) (MD)
(500C) (10C) (11C) (200C)
(DC) (MO) (MI)
CIRCLE 748

Delta Products Corp.
3225 Laurelview Ct.
Fremont, CA 94538
(510) 770-0660
(50S) (51S) (10S) (11S)
(200S) (RM) (OF) (PF) (50C)
(10C) (11C) (DC) (AC) (50R)
(10R) (11R) (200R) (SW)
CIRCLE 749

(see p. 131 for key)
(continued on p. 125)

▼ TWIN SCHOTTKY DIODES OFFER 60-A OPERATION

High current, high voltage, high I_{FSM}, and low forward-voltage drop are all features of the S60SC Series of twin Schottky barrier diodes. The devices offer a 60-A operating current and come in three voltage ranges of 30 V, 40 V, and a 60-V version that features a forward surge-current capability of 500 A. They come in a modified plastic PO-3 (MTO-3P) through-hole package in a center-tapped, common-cathode configuration. Pricing in lots of 1000 is \$3.85 with delivery from stock to four weeks.



Shindengen America Inc.
2985 E. Hillcrest Dr., Suite 140
Westlake Village, CA 91362
(800) 634-3654
▶ CIRCLE 605

▼ 1100-V MOSFET BREAKS 1-Ω BARRIER

Claimed as the industry's highest voltage MOSFET in a TO-247 plastic package, the IXTH13N110 MOSFET uses the company's size-8 die to provide an 1100-V BV_{DSS} blocking capability with an on-resistance of 0.92 Ω. The device, which is rated for continuous operation at 13 A, gives designers more blocking-voltage headroom for higher system reliability without extracting a penalty in on-resistance. Applications include video-projection equipment, high-resolution graphics monitors, radar pulse modulators, electro-surgical equipment, and other high-voltage power-conversion circuits. Pricing in lots of 1000 is \$18.63.

IXYS Corp.
3540 Bassett St.
Santa Clara, CA 95054
(408) 982-0700
▶ CIRCLE 606

POWER-SOURCE MANUFACTURERS

Deltec Electronics Corp.
2727 Kurtz St.
San Diego, CA 92110
(619) 291-4211
(UN)
CIRCLE 750

Deltron Inc.
P.O. Box 1369
290 Wissahickon Ave.
North Wales, PA 19454
(215) 699-9261
(50S) (11S) (200S) (OF) (PF)
CIRCLE 751

Digital Data Systems Inc.
1551 N.W. 65th Ave.
Ft. Lauderdale, FL 33313
(305) 792-3290
(50S) (RM) (OF) (MD)
(UN) (50C) (DC) (MI)
CIRCLE 752

Digital Power Corp.
41920 Christy St.
Fremont, CA 94538-3158
(510) 657-2635
(50S) (11S) (200S) (OF)
(RP) (PF) (50C) (11C)
(200C) (DC) (SW)
CIRCLE 753

Duracell Inc.
New Products
& Technology
Berkshire Corporate Park
Bethel, CT 06801
(800) 544-5454
(AL) (LT) (NM) (ZA)
CIRCLE 754

EFI Electronics Corp.
Industrial Products Div.
2415 South 2300 West
Salt Lake City, UT 84119
(801) 977-9009
(200S) (UN)
CIRCLE 755

EG&G Power Systems
1330 E. Cypress St.
Covina, CA 91724
(818) 967-9521
(50S) (51S) (11S) (200S) (MD)
(PF) (50C) (51C) (11C) (200C)
(DC) (MO) (MI) (50R) (51C)
(11R) (200R) (SW) (MU) (ML)
CIRCLE 756

EMCO
Component Specialties Div.
1172 Route 109
Lindenhurst, NY 11757
(516) 957-8700
(50S) (LA) (50C) (AC)
CIRCLE 757

EPE Technologies
Subsidiary of Square D
1660 Scenic Ave.
Costa Mesa, CA 92626
(714) 557-1636
(200S) (RM) (UN) (PF)
CIRCLE 758

Eagle Picher Industries Inc.
Commercial Products Dept.
P.O. Box 130
Seneca, MO 64865
(417) 776-2256
(UN) (LC) (LT) (NH)
CIRCLE 759

Eagle-Picher Industries Inc.
Electronics Div.
C & Porter Sts., P.O. Box 47
Joplin, MO 64802
(417) 623-8000
(MD) (UN) (LC) (LT) (NC)
(NH) (NM) (SO) (ZA)
CIRCLE 760

East Penn Mfg. Co. Inc.
Deka Road
Lyon Station, PA 19536
(619) 682-6361
(LC)
CIRCLE 761

Edal Industries Inc.
4 Short Beach Rd.
East Haven, CT 06512
(203) 467-2591
(RE)
CIRCLE 762

Electroid Co.
45 Fadem Rd.
Springfield, NJ 07081
(201) 467-8100
(50S)
CIRCLE 763

Electronic Measurements Inc.
405 Essex Rd.
Neptune, NJ 07753
(908) 922-9300
(200S) (LA) (RM) (CV)
(RP) (PF) (11C) (200C)
(DC) (AC) (LI) (SW) (MU)
CIRCLE 764

Elenco Electronics Inc.
150 W. Carpenter St.
Wheeling, IL 60090
(708) 541-3800
(50S) (LA)
CIRCLE 765

Elgar Corp.
9250 Brown Deer Rd.
San Diego, CA 92121
(619) 450-0085
(51S) (200S) (LA) (RM)
(PR) (RP) (51C) (200C)
(MO) (51R) (200R) (LI)
CIRCLE 766

Elpac Power Systems
6527 Paseo Diego
Anaheim, CA 92714
(714) 476-6070
(50S)
CIRCLE 767

Energizer Power Systems
P.O. Box 147114
U.S. Hwy. 441 N.
Gainesville, FL 32614-7114
(904) 462-4726
(AL) (CZ) (LT) (ME) (NC)
(MN) (SO) (ZA) (ZC)
CIRCLE 768

Engineered Magnetics Inc.
18435 Susana Rd.
Rancho Dominquez, CA
90221
(310) 635-9555
(50S) (51S) (11S) (200S)
(RM) (CV) (PR) (MD) (PF)
(50C) (51C) (11C) (200C)
(DC) (AC) (MI) (50R) (51R)
(11R) (200R) (SW) (ML)
CIRCLE 769

Entran Devices Inc.
10 Washington Ave.
Fairfield, NJ 07004
(201) 227-1002
(50S)
CIRCLE 770

Ericsson Components Inc.
Power Products Group
403 International Pkwy.
Richardson, TX 75081
(214) 997-6561
(50C) (51C) (10C) (11C)
(DC) (MO)
CIRCLE 771

Eveready Battery
Energizer Power Systems
P.O. Box 147114
Gainesville, FL 32614-7114
(904) 462-3911
(AL) (CZ) (LT) (ME) (NC)
(NM) (SO) (ZA) (ZC)
CIRCLE 772

Farnell Advance Power
3211 Aurora Rd.
Solon, OH 44139
(216) 349-0755
(50S) (11S) (200S) (RM) (OF)
(CV) (RP) (PF) (50C) (11C)
(200C) (DC)
CIRCLE 917

Fedco Electronics Inc.
P.O. Box 1403
Fond Du Lac, WI 54936
(800) 542-9761
(AL) (CZ) (LC) (LT) (ME)
(NC) (NM)
CIRCLE 773

Fluke Corp.
Diagnostic Tools Div.
6920 Seaway Blvd.
Everett, WA 98203
(206) 356-6459
(51S) (11S) (LA) (RM)
(CV) (RP)
CIRCLE 774

Fortron/Source Corp.
2925 Bayview Dr.
Fremont, CA 94538
(510) 440-0188
(50S) (11S) (200S) (OF) (50C)
(10C) (DC) (AC) (LI) (SW)
CIRCLE 775

Gamma High Voltage Research
1096 North U.S. Hwy. 1
Ormond Beach, FL 32174
(904) 677-7070
(51S) (500S) (10S) (11S)
(200S) (LA) (RM) (CV) (RP)
(51C) (500C) (10C) (11C)
(200C) (DC) (MO)
CIRCLE 776

Gates Energy Products Inc.
Industrial Battery Div.
617 North Ridgeview Dr.
Warrensburg, MO 64093-9301
(816) 429-2165
(LC)
CIRCLE 777

Glassman High Voltage
P.O. Box 551
Whitehouse Station, NJ 08889
(908) 534-9007
(500S) (200S) (LA) (RM)
(CV) (RP) (PF)
CIRCLE 778

Golden Systems Inc.
2125-B Madera Rd.
Simi Valley, CA 93065
(805) 582-4417
(50S) (10S) (11S)
(200S) (OF)
CIRCLE 779

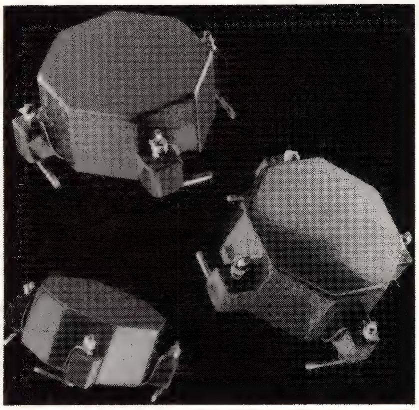
HC Power Inc.
17032 Armstrong Ave.
Irvine, CA 92714-5716
(714) 261-2200
(50S) (200S) (LA) (RM) (CV)
(PR) (RP) (MD) (PF) (50C)
(200C) (DC) (AC) (50R)
(200R) (SW) (MU) (ML)
CIRCLE 780

(see p. 141 for key)

(continued on p. 126)

▼ TOROIDAL TRANSFORMERS OFFER VERSATILITY

The Power-Pac, a surface-mount toroidal transformer, can be configured as a wide-range flyback transformer, a 1:1 pulse transformer, or a high-energy inductor. The device provides a low dc resistance, minimal core losses, and a bandwidth greater than 1 MHz. Standard and custom values are available. Mechanically, the unit is similar to the Octa-Pac toroidal transformer from Coiltronics, Pompano Beach, Fla., and serves as a drop-in replacement in many cases. Call for pricing and delivery.



GFS Manufacturing Inc.
140 Crosby Rd.
Dover, NH 03820-4371
(603) 742-4375
▶CIRCLE 607

▼ DC-INPUT SUPPLIES PROVIDE 1200 W OUT

Configured as three hot-pluggable modules standing 3.5 in. high in a 19-in.-wide rack-mount case, the TPQ Series of dc-input power systems provide up to 1200 W of output with N+1 redundancy. The three units automatically share current and integral isolation diodes ensure that an output failure by one module will not affect the output of the others. Dc-input voltage is 48 V nominal with a range of 42 to 56 V dc. Each module can deliver from 250 to 600 W and each has its own cooling fan. One to four outputs are available from 2 to 48 V dc. Unit prices start at $2355. Samples are available in four to six weeks with production lots in eight to 10 weeks.

Unipower Corp.
3900 Coral Ridge Dr.
Coral Springs, FL 33065
(305) 346-2442
▶CIRCLE 608

POWER-SOURCE MANUFACTURERS

Harris Semiconductor
Semiconductor Products
P.O. Box 883
Melbourne, FL 32902
(407) 724-3802
(BT) (MF) (RE) (TH) (PI) (PC)
CIRCLE 781

Hawker Energy Products
4318 Rainbow Blvd.
Suite 730
Kansas City, KS 66103
(800) 730-7733
(LC)
CIRCLE 782

Hewlett-Packard Co.
Direct Marketing
Organization
P.O. Box 58059, M/S 51L-SJ
Santa Clara, CA 95051-8059
(800) 452-4844
(50S) (51S) (500S) (10S)
(11S) (200S) (LA) (RM)
(CV) (RP)
CIRCLE 783

Hitran Corp.
362 Hwy. 31
Flemington, NJ 08822
(908) 782-5525
(200) (CV) (LI)
CIRCLE 784

Hydrocap Corp.
975 N.W. 95th St.
Miami, FL 33150-2095
(305) 696-2504
(LC) (NC)
CIRCLE 785

ILC Data Device Corp.
105 Wilbur Pl.
Bohemia, NY 11716
(516) 567-5600
(50C) (11C) (DC) (MO) (MI)
CIRCLE 786

IXYS Corp.
3540 Bassett St.
Santa Clara, CA 95054
(408) 982-0700
(BT) (MF) (RE) (TH) (PI) (PC)
CIRCLE 787

International Power
DC Power Supplies Inc.
360 Bernoulli Cir.
Oxnard, CA 93030-5167
(800) 845-5386
(50S) (51S) (10S) (11S)
(200S) (RM) (OF) (50R) (51R)
(10R) (11R) (200R) (LI)
CIRCLE 788

International Power Devices
20 Linden St.
Boston, MA 02134
(617) 782-3331
(50C) (51C) (10C) (11C)
(200C) (DC) (MO) (IC)
CIRCLE 789

International Power Sources
200 Butterfield Dr.
Ashland, MA 01721
(508) 881-7434
(50S) (OF) (50C) (DC) (MO)
(IC)
CIRCLE 790

Interpoint Corp.
Power Products Div.
10301 Willow Rd.
Redmond, WA 98052
(206) 882-3100
(50S) (51S) (10S) (11S)
(200S) (CV) (MD) (UN) (PF)
(50C) (51C) (10C) (11C)
(200C) (DC) (MO) (IC) (MI)
CIRCLE 791

James Electronics Inc.
4050 N. Rockwell St.
Chicago, IL 60618
(312) 463-6500
(50S) (10S) (11S) (200S) (RM)
(OF) (CV) (UN) (50C) (DC)
(AC) (MO) (50R) (10R) (11R)
(200R) (LI) (SW) (MU)
CIRCLE 792

Jerome Industries Corp.
730 Division St.
Elizabeth, NJ 07201
(908) 353-5700
(50S) (10S) (OF) (CV)
(UN) (10C) (DC)
CIRCLE 793

Jeta Power Systems Inc.
2675 Junipero Ave.
Signal Hill, CA 90806
(310) 427-0095
(50S) (200S) (CV) (PF)
(200C) (DC) (200R) (SW)
CIRCLE 794

K&M Electronics Inc.
11 Interstate Dr.
West Springfield, MA 01089
(413) 781-1350
(500S) (10S) (CV) (RP) (MD)
(500C) (10C) (DC) (MI)
CIRCLE 795

KGS Electronics
A Gar Enterprise Co.
418 E. Live Oak Ave.
Arcadia, CA 91106-5690
(818) 574-1175
(50S) (51S) (10S) (11S)
(200S) (LA) (RM) (CV)
(RP) (MD) (UN) (PF) (50C)
(51C) (10C) (11C) (200C)
(DC) (AC) (MO) (MI) (50R)
(51R) (10R) (11R) (200R)
(LI) (SW) (MU) (ML)
CIRCLE 796

Kepco Inc.
131-38 Sanford Ave.
Flushing, NY 11352
(718) 461-7000
(50S) (51S) (500S) (10S)
(11S) (200S) (LA) (RM)
(OF) (CV) (RP) (PF) (50C)
(10C) (11C) (200C) (DC) (MO)
(50R) (LI) (SW) (MU)
CIRCLE 797

Kikusui International Corp.
1980 Orizaba Ave.
Signal Hill, CA 90804-1203
(310) 986-1677
(50S) (51S) (500S) (10S)
(11S) (200S) (LA) (RM) (CV)
(PR) (RP) (50R) (51R) (500R)
(10R) (11R) (200R) (LI) (SW)
CIRCLE 798

LH Research Inc.
14402 Franklin Ave.
Tustin, CA 92680
(714) 730-0162
(50S) (11S) (200S) (OF)
(CV) (RP) (UN) (PF) (50C)
(11C) (200C) (DC) (MO) (50R)
(11R) (200R) (SW)
CIRCLE 799

LZR Electronics Inc.
8051 Cessna Ave.
Gaithersburg, MD 20879
(301) 921-4600
(50S) (51S) (LA) (OF) (CV)
(PR) (50C) (51C) (DC) (AC)
CIRCLE 800

Lambda Electronics Inc.
515 Broad Hollow Rd.
Melville, NY 11747-3700
(516) 694-4200
(50S) (51S) (10S) (11S)
(200S) (LA) (RM) (OF) (CV)
(RP) (MD) (UN) (PF) (50C)
(51C) (10C) (11C) (200C)
(DC) (MO) (MI)
CIRCLE 801

Lambda Novatronics Inc.
500 S.W. 12th Ave.
P.O. Box 878
Pompano Beach, FL 33061
(305) 784-2477
(50S) (51S) (500S) (11S)
(200S) (RM) (OF) (CV) (MD)
(PF) (50C) (51C) (500C) (11C)
(200C) (DC) (MO) (MI) (50R)
(51R) (500R) (11R) (200R)
(SW) (MU) (ML)
CIRCLE 802

Lambda Qualidyne Inc.
3055 Del Sol Blvd.
San Diego, CA 92154
(619) 575-1100
(50S) (51S) (11S) (200S) (RM)
(OF) (CV) (RP) (UN) (PF)
(50C) (51C) (11C) (200C)
(DC) (AC) (MO) (50R) (51R)
(11R) (200R) (SW) (MU)
CIRCLE 803

Lamp Technology Inc.
1645 Sycamore Ave.
Bohemia, NY 11716
(516) 567-1800
(AL)
CIRCLE 804

Liebert Corp.
1050 Dearborn Dr.
Columbus, OH 43229
(614) 888-0246
(51S) (500S) (11S) (200S)
(LA) (RM) (OF) (CV) (PR)
(RP) (MD) (UN) (PF) (51C)
(500C) (11C) (200C) (AC)
(MO) (MI) (51R) (500R) (11R)
(200R) (LI) (SW) (MU) (ML)
CIRCLE 805

Linear Technology Corp.
1630 McCarthy Blvd.
Milpitas, CA 95035
(408) 432-1900
(50C) (51C) (10C) (11C)
(200C) (DC) (IC) (MI) (50R)
(10R) (11R) (200R) (LI) (SW)
(ID) (ML) (PI) (PC)
CIRCLE 806

(see p. 131 for key)
(continued on p. 127)

POWER-SOURCE MANUFACTURERS

Logitek Inc.
101 Christopher St.
Ronkonkoma, NY 11779-6922
(516) 467-4200
(50S) (11S) (200S) (RM) (MD)
(PF) (50C) (11C) (200C) (DC)
(AC) (MO) (MI)
CIRCLE 807

Lutze Inc.
1911-A Associates Ln.
Charlotte, NC 28217
(704) 357-8835
(50S) (OF) (CV) (UN) (DC)
(AC) (MO)
CIRCLE 808

MIL Electronics Inc.
One Chestnut St.
Nashua, NH 03063
(603) 882-3200
(50S) (51S) (500S) (10S)
(11S) (CV) (RP) (MD) (50C)
(51C) (500C) (10C) (11C)
(DC) (MO) (MI) (50R) (51R)
(500R) (10R) (11R) (LI) (SW)
(MU) (ML)
CIRCLE 809

Maxell Corp.
Battery Div.
22-08 Route 208
Fair Lawn, NJ 07410
(201) 794-5900
(AL) (CZ) (LT) (NM) (SO)
CIRCLE 916

Maxim Integrated Products
120 San Gabriel Dr.
Sunnyvale, CA 94086
(408) 737-7600
(50S) (50C) (DC) (50R)
(LI) (SW) (ID) (ML)
CIRCLE 810

Melcher Inc.
187 Billerica Rd.
Chelmsford, MA 01824
(508) 256-1812
(50S) (RM) (RP) (MD)
(PF) (50C) (10C) (11C)
(200C) (DC) (MO) (IC)
(MI) (50R) (10R) (11R)
(200R) (SW) (ID) (ML)
CIRCLE 811

Micrel Semiconductor
1849 Fortune Dr.
San Jose, CA 95131
(408) 944-0800
(50R) (LI) (SW) (ID)
(MF) (PI) (PC)
CIRCLE 812

Micro Energy Inc.
Development Center
745 W. State Rd., 434
Longwood, FL 32750-4909
(708) 501-5000
(50S) (11S) (200S) (OF)
(CV) (PF) (50C) (10C)
(11C) (DC) (50R) (10R)
(11R) (200R) (SW)
CIRCLE 813

Micro Linear Corp.
2092 Concourse Dr.
San Jose, CA 95131
(408) 433-5200
(50C) (51C) (500C) (10C)
(11C) (200C) (DC) (IC)
(50R) (51R) (500R) (10R)
(11R) (200R) (LI) (SW)
(ID) (PI) (PC)
CIRCLE 814

Modular Devices Inc.
4115 Spencer St.
Torrance, CA 90503
(310) 542-8561
(50S) (11S) (200S) (RM)
(OF) (RP) (UN) (PF) (50C)
(11C) (200C) (DC)
CIRCLE 815

Modular Devices Inc.
One Roned Rd.
Brookhaven R&D Pl.
Shirley, NY 11967
(516) 345-3100
(50S) (51S) (500S) (10S)
(11S) (200S) (RM) (OF) (CV)
(PR) (RP) (MD) (UN) (PF)
(50C) (51C) (500C) (10C)
(11C) (200C) (DC) (AC) (MO)
(IC) (MI) (50R) (51R) (500R)
(10R) (11R) (200R) (LI) (SW)
(MU) (ID) (ML)
CIRCLE 816

Motorola
Power Products
5005 E. McDowell Rd.
Phoenix, AZ 85008
(602) 244-5757
(BT) (MF) (RE) (TH) (PI) (PC)
CIRCLE 817

Multiplier Industries Corp.
135 Radio Circle
Mt. Kisco, NY 10549
(914) 241-9510
(AL) (CZ) (LC) (LT) (NC) (NM)
CIRCLE 818

NH Research Inc.
16601 Hale Ave.
Irvine, CA 92714
(714) 474-3900
(50S) (51S) (10S) (11S)
(200S) (RM) (CV) (RP) (MD)
CIRCLE 819

Natel Engineering Co. Inc.
Power Microelectronics
845 Rancho Conejo Blvd.
Newbury Park, CA 91320
(805) 376-5500
(BT) (MF) (RE) (TH) (PI) (PC)
CIRCLE 820

National Custom Enterprises
400 Gateway Blvd.
Burnsville, MN 55337-2559
(612) 890-1360
(AL) (CZ) (LC) (LT) (NC) (NM)
(SO) (ZA)
CIRCLE 821

National Semiconductor Corp.
Analog - Power Management
2900 Semiconductor Dr.
MS/16-171
Santa Clara, CA 95052
(408) 721-2511
(50C) (51C) (DC) (IC) (MI)
(51R) (LI) (SW) (ID) (ML) (BT)
(MF) (RE) (PI) (PC)
CIRCLE 822

Nova Electric
Div. of Technology Dynamics
100 Schoool St.
Bergenfield, NJ 07621
(201) 385-0500
(200S) (RM) (PR) (MD) (UN)
(PF) (200C) (AC) (MI)
CIRCLE 823

OECO Corp.
4607 S.E. International Way
Milwaukie, OR 97222
(503) 659-7932
(50S) (51S) (500S) (11S)
(200S) (RM) (OF) (RP) (MD)
(PF) (50C) (51C) (500C) (11C)
(11C) (200C) (DC) (MO) (MI)
CIRCLE 824

ONEAC Corp.
27944 N. Bradley Rd.
Libertyville, IL 60048
(800) 327-8801
(11S) (200S) (UN)
CIRCLE 825

OPT Industries Inc.
300 Red School Ln.
Phillipsburg, NJ 08865
(908) 454-2600
(50S) (51S) (200S) (RM) (OF)
(CV) (MD) (UN) (PF) (50C)
(51C) (200C) (DC) (MI) (50R)
(51R) (200R) (LI) (SW) (ML)
CIRCLE 826

Omega Engineering Inc.
P.O. Box 4047
Stamford, CT 06907
(203) 359-1660
(50S) (10S) (LA) (RM)
(RP) (AL) (NC)
CIRCLE 827

Omnirel Corp.
205 Crawford St.
Leominster, MA 01611
(508) 534-5776
(50C) (11C) (DC) (50R) (LI)
(SW) (ML) (BT) (MF) (RE)
CIRCLE 828

On-Line Power
5701 Smithway
Commerce, CA 90040
(213) 721-5017
(200S) (UN)
CIRCLE 829

Onan Power/Electronics
9713 Valley View Rd.
Minneapolis, MN 55344-3508
(612) 943-4600
(50S) (51S) (10S) (11S)
(200S) (RM) (OF) (CV) (RP)
(UN) (PF) (50C) (51C) (10C)
(11C) (200C) (DC) (AC)
CIRCLE 830

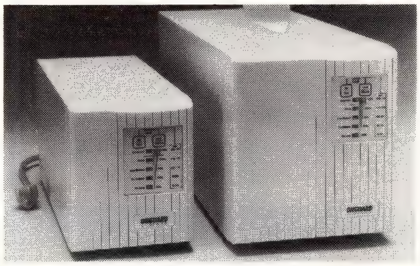
Pacific Power Source Corp.
15122 Bolsa Chica St.
Huntington Beach, CA 92649
(714) 898-2691
(51S) (200S) (LA) (RM) (CV)
(PR) (RP) (UN) (PF)
CIRCLE 831

(see p. 131 for key)

(continued on p. 128)

▼ INTELLIGENT UPSs GUARD EQUIPMENT

Targeted at local-area networks and midrange systems, the OnGuard LI-600 and LI-1000 intelligent, line-interactive UPSs protect sensitive equipment from damaging power instabilities. Both incorporate built-in microprocessors and RS-232 interfaces that enable real-time communication across the network between the UPS, workstations, servers, or network-management stations. The units' CPU drives advanced network monitoring, including the Simple Network Management protocol and Novell's NetWare management system. Also featured is a DOS/Windows menu-driven diagnostic application that provides analysis of the line power in real time, inspects battery conditions, and provides power event and data logs. Pricing for the OnGuard LI-600 and LI-1000 is $599 and $849, respectively.



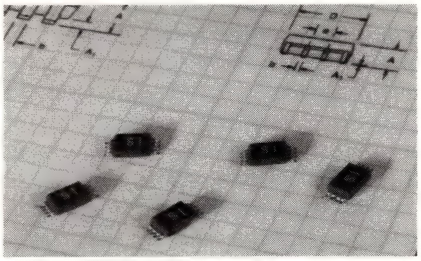
Clary Corp.
1960 S. Walker Ave.
Monrovia, CA 91016
(800) 442-5279
▶CIRCLE 609

▼ TO-3 MOSFETs RANGE TO 1000 V/35 A

With ratings from 50 to 1000 V at up to 35 A, a line of power MOSFETs in TO-3 metal packages suits military applications such as switching power supplies, motor controls, and other power-management circuits. The devices are functional equivalents to MOSFETs from manufacturers such as APT, International Rectifier, and IXYS. They offer high energy capabilities and low on-resistance specifications. All are available in high-reliability versions screened to either TX or TXV levels. Call for pricing and delivery information.

Omnirel Corp.
205 Crawford St.
Leominster, MA 01453
(508) 534-5776
▶CIRCLE 610

▼ POWER MOSFETs DRIVE PCMCIA CIRCUITRY



Combining high-density n- and p-channel technologies with TSSOP packaging, the Lite Foot family of power MOSFETs are small enough to fit into any standard PCMCIA card and are half the size of any comparable power MOSFETs available. Six devices are offered initially, including a single p-channel device with a maximum on-resistance of 75 mΩ and a single n-channel with a maximum of 50 mΩ. The eight-lead devices dissipate over 1.5 W without any external heat sinking other than the pc board itself. They stand 1.1 mm tall and occupy an area of 19 mm^2 on the board. In addition to saving space, the Lite Foot MOSFETs make battery-operated equipment more efficient and less costly to build. Samples of all six devices are available now with production lots shipping in the third quarter. Pricing in lots of 100,000 starts at $0.88.

Siliconix
2201 Laurelwood Rd.
Santa Clara, CA 95056-0951
(800) 554-5565, ext. 27
▶CIRCLE 611

▼ P-CHANNEL MOSFET BOASTS LOW $R_{DS(ON)}$

The lowest on-resistance for a p-channel MOSFET in an SOT-23 package is claimed for the TP2106K1. Specifications include a minimum breakdown voltage of –60 V, a maximum gate-to-source threshold voltage of –2 V, and a maximum drain-to-source on-resistance of 6 Ω at V_{GS} of –10 V and I_D of –0.5 A. Applications include battery-operated systems, medical equipment, telecom equipment and instrumentations, and more. Pricing is $0.35 in lots of 1000.

Supertex Inc.
1350 Bordeaux Dr.
Sunnyvale, CA 94089
(408) 744-0100
▶CIRCLE 612

POWER-SOURCE MANUFACTURERS

Panasonic Industrial Co.
Two Panasonic Way
Panazip: 7C-7
Secaucus, NJ 07094
(201) 392-5244
(50S) (10S) (11S) (50R) (BT) (MF) (PI) (PC)
CIRCLE 832

Panasonic Industrial Co.
Battery Sales Group
Two Panasonic Way
Secaucus, NJ 07094
(201) 348-5266
(AL) (CZ) (LC) (LT) (NC) (NM) (SO) (ZA) (ZC)
CIRCLE 833

Philips
Power Systems
Boulevard de l'Europe 131
B 1301 Wavre, Belgium
+32-10-438502
(50S) (51S) (10S) (11S) (200S) (RM) (OF) (UN) (PF) (50C) (DC) (MO)
CIRCLE 834

Philips Components
Discrete Products Div.
2001 W. Blue Heron Blvd.
Riviera Beach, FL 33436
(407) 881-3308
(BT) (MF) (RE) (TH)
CIRCLE 835

Phoenix Contact Inc.
P.O. Box 4100
Harrisburg, PA 17111-0100
(717) 944-1300
(50S) (10S) (11S) (LA) (CV) (10C) (11C) (DC) (MO) (50R) (10R) (11R) (LI) (SW) (MU)
CIRCLE 836

Pico Electronics Inc.
Power Products
453 N. MacQuesten Pkwy.
Mount Vernon, NY 10552
(800) 431-1064
(50S) (11S) (OF) (MD) (500C) (11C) (DC) (MO) (MI)
CIRCLE 837

Pioneer Magnetics Inc.
1745 Berkeley St.
Santa Monica, CA 90404
(310) 829-6751
(50S) (51S) (11S) (200S) (RM) (UN) (PF) (50C) (51C) (11C) (200C) (DC) (AC) (MO) (50R) (51R) (11R) (200R) (LI) (SW) (MU)
CIRCLE 838

Portable Energy Products
940 Disc Dr.
Scotts Valley, CA 95066
(408) 439-5100
(LC)
CIRCLE 839

Power Conversion Products Inc.
42 East St.
P.O. Box 380
Crystal Lake, IL 60039-0380
(815) 459-9100
(50S) (51S) (RM) (CV) (PF) (50C) (DC)
CIRCLE 840

Power Convertibles
3450 S. Broadmont Dr.
Tucson, AZ 85713
(602) 628-8292
(50S) (51S) (500S) (OF) (CV) (PF) (50C) (51C) (500C) (DC) (AC) (MO) (IC) (50R) (51R) (500R) (10R) (11R) (LI) (SW) (MU) (ID)
CIRCLE 841

Power General
152 Will Dr.
Canton, MA 02021
(617) 828-6216
(50S) (10S) (11S) (200S) (OF) (50C) (10C) (11C) (DC) (MO) (IC)
CIRCLE 842

Power Integrations Inc.
411 Clyde Ave.
Mountain View, CA 94043
(415) 960-3572
(PI) (PC)
CIRCLE 843

Power Solutions Inc.
17 Hunters Ln.
Roslyn, NY 11576
(516) 627-6032
(50S) (51S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (PF) (50C) (51C) (10C) (11C) (200C) (DC) (MO) (50R) (51R) (10R) (11R) (200R)
(LI) (SW) (MU) (ID)
CIRCLE 844

Power Switch Corp.
17 Vreeland St.
Lodi, NJ 07644
(201) 478-5788
(10S) (11S) (200S) (OF) (CV) (PF) (50C) (51C) (11C) (200C) (DC) (AC) (MO) (50R) (11R) (LI) (SW)
CIRCLE 845

Power Ten Inc.
486 Mercury Dr.
Sunnyvale, CA 94086
(408) 738-5959
(50S) (51S) (500S) (200S) (LA) (RM) (CV) (RP) (MD) (SW)
CIRCLE 846

Power Trends Inc.
1101 N. Raddant Rd.
Batavia, IL 60510
(708) 406-0900
(50C) (51C) (11C) (DC) (MO) (50R) (10R) (11R) (SW) (MU)
CIRCLE 847

Power-One Inc.
740 Calle Plano
Camarillo, CA 93012
(805) 987-8741
(50S) (51S) (10S) (11S) (200S) (OF) (CV) (UN) (PF)
CIRCLE 848

Power-Sonic Corp.
3106 Spring St.
Redwood City, CA 94063
(415) 306-1186
(LC) (NC)
CIRCLE 849

PowerTech Inc.
0-02 Fair Lawn Ave.
Fair Lawn, NJ 07410
(201) 791-5050
(BT) (PC)
CIRCLE 850

Powercard Corp.
393 Totten Pond Rd.
Waltham, MA 02154-2014
(617) 890-6789
(AL) (CZ) (LT)
CIRCLE 851

Powercube Corp.
8 Suburban Park Dr.
Billerica, MA 01821
(508) 667-9500
(50S) (11S) (200S) (RP) (MD) (50C) (11C) (200C) (DC) (MO) (MI)
CIRCLE 852

Powerex Inc.
200 Hillis St.
Youngwood, PA 15697-1800
(412) 925-7272
(BT) (PI)
CIRCLE 853

Preferred Electronics Inc.
Mainline Dr., P.O. Box 248
Westfield, MA 01086
(413) 568-2301
(50S) (51S) (500S) (10S) (11S) (200S) (RM) (OF) (CV) (PR) (RP) (MD) (UN) (PF) (50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MO) (MI) (LI) (SW) (MU) (ML)
CIRCLE 854

RO Associates Inc.
246 Caspian Dr.
Sunnyvale, CA 94089
(408) 744-1450
(50S) (11S) (200S) (RM) (CV) (MD) (50C) (11C) (200C) (DC) (MO) (MI)
CIRCLE 855

Rantec Microwave & Electronics
24003 Ventura Blvd.
Calabasas, CA 91302
(818) 591-8189
(50S) (11S) (200S) (CV) (MD) (PF) (50C) (51C) (11C) (200C) (DC) (MO) (MI)
CIRCLE 856

Rantec Microwave & Electronics
An Esco Co.
1173 Los Olivos Ave.
Los Osos, CA 93402
(805) 528-5858
(500S) (10S) (11S) (OF) (CV) (MD)
CIRCLE 857

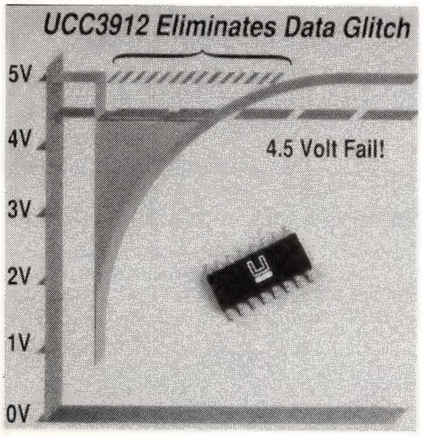
Rayovac Corp.
Technical Sales
P.O. Box 44960
Madison, WI 53744-4960
(608) 275-4589
(AL) (CZ) (LT) (ME) (SO) (ZA) (ZC)
CIRCLE 858

Raytheon Quincy
Missile Systems Div.
465 Centre St.
Quincy, MA 02169
(617) 984-8570
(50C) (11C) (200C) (DC) (MI)
CIRCLE 859

Reich Associates Inc.
Route 4, Box 4620
Lakehills, TX 78063
(210) 751-3220
(50S) (51S) (500S) (10S) (11S) (200S) (LA) (RM) (OF) (CV) (MD) (PF) (50C) (51C) (500C) (10C) (11C) (200C) (DC) (AC) (MI) (50R) (51R) (500R) (10R) (11R) (200R) (LI) (SW) (ML)
CIRCLE 860

(see p. 131 for key)
(continued on p. 129)

▼ ELECTRONIC BREAKER SIMPLIFIES CIRCUITS



A single-chip answer to hot-swap, power-management, and adaptive fault protection is found in the UCC3912 electronic circuit breaker. Featuring an on-board uni-directional switch, the device eliminates protection diodes, fuses, and external drive circuits. It's specifically designed to protect system modules from overcurrent conditions and power/data glitches during hot-swap and fault conditions, while managing the system power budget. The devices has two primary functions: adaptive fault protection and power management. As a fault protector, it replaces fuses, polyfuses, and more. For power management, it provides a programmable start delay for hot-swap sequencing, soft start, and increased power control. Pricing is $2.50 in lots of 1000. Samples and production quantities are available now.

Unitrode Integrated Circuits Corp.
7 Continental Blvd.
Merrimack, NH 03054-0399
(603) 424-2410
▶CIRCLE 613

▼ MOS GATE DRIVERS DISPLACE DISCRETES

A pair of drivers for discrete MOS power devices offers the reliability of solid-state technology and a cost comparable to that of gate-drive transformers. The ATT2101 low-side driver and ATT2102 high-side gate-driver chip set is produced in AT&T's HVC800 (high-voltage CMOS) process, which combines 3-μm CMOS with 800-V NMOS devices. The result is cost-effective smart-power ICs. The set features a quick-response 2-A sink and source output for driving MOS gates. The high-voltage level shift from 5 V up to 800 V translates to a cost-effective, direct interface between the logic and high-voltage loads. Applications include high-frequency switching supplies, inverters, motor drives, and lamp ballasts. Pricing for the set is under $1 in OEM lots.

AT&T Microelectronics
Dept. AL-500404200
555 Union Blvd.
Allentown, PA 18103
(800) 372-2447, Dept. P07
▶CIRCLE 614

POWER-SOURCE MANUFACTURERS

Reliability Inc.
Power Products Div.
P.O. Box 218370
Houston, TX 77218
(713) 492-0550
(50C) (DC) (SW)
CIRCLE 861

Renata Batteries U.S.
990 N. Bowser Rd., Suite 900
Richardson, TX 75081
(214) 234-8091
(AL) (LT) (ME) (SO) (ZA)
CIRCLE 862

Resonant Power Technology Inc.
1926 Junction Ave.
San Jose, CA 95131-2102
(408) 441-0800
(50S) (51S) (11S) (200S)
(OF) (MD) (PF)
CIRCLE 863

SAGER Electronics
60 Research Rd.
Hingham, MA 02043
(617) 749-6700
(50S) (51S) (500S) (10S)
(11S) (200S) (RM) (PF) (50C)
(51C) (500C) (10C) (11C)
(200C) (DC) (AL) (LT)
CIRCLE 864

SGS-THOMSON Microelectronics
55 Old Bedford Rd.
Lincoln, MA 01773
(617) 259-0300
(50C) (DC) (LI) (SW) (BT)
(MF) (RE) (TH) (PI) (PC)
CIRCLE 865

Samsung Semiconductor Inc.
3655 N. First St.
San Jose, CA 95134
(408) 954-7229
(50R) (10R) (ID) (BT)
(MF) (PI) (PC)
CIRCLE 866

Sanyo Energy (U.S.A.) Corp.
2001 Sanyo Ave.
San Diego, CA 92173
(619) 661-6620
(AL) (LT) (NC) (NM)
CIRCLE 867

Schaefer Inc.
200 Butterfield Dr.
Ashland, MA 01721
(508) 879-8658
(50S) (51S) (11S) (200S)
(RM) (50C) (51C) (11C)
(200C) (DC) (AC) (SW)
CIRCLE 868

Semiconductor Circuits Inc.
Sub. of Astec America Inc.
49 Range Rd.
Windham, NH 03087
(603) 893-2330
(50S) (51S) (10S) (11S) (LA)
(RM) (CV) (50C) (51C) (10C)
(11C) (DC) (MO) (IC)
CIRCLE 869

Semtech Corp.
652 Mitchell Rd.
Newbury Park, CA 91320
(805) 498-2111
(50C) (10C) (11C) (200C)
(DC) (AC) (MO) (IC) (50R)
(10R) (11R) (LI) (SW) (MU)
(ID) (ML) (BT) (RE) (PI) (PC)
CIRCLE 870

Shindengen America Inc.
2985 E. Hillcrest Dr.
Westlake Village, CA 91362
(805) 373-1130
(50S) (51S) (10S) (11S)
(200S) (OF) (CV) (PF) (50C)
(10C) (11C) (200C) (DC) (AC)
(MO) (50R) (10R) (11R) (SW)
(MU) (BT) (MF) (RE) (PI) (PC)
CIRCLE 871

Shogyo International Corp.
287 Northern Blvd.
Great Neck, NY 11021-4799
(516) 466-0911
(50S) (51S) (500S) (10S)
(11S) (200S) (CV) (UN) (PF)
(50C) (51C) (10C) (11C)
(200C) (DC) (AC) (MO) (50R)
(LI) (MU) (AL) (CZ) (LT) (ME)
(NC) (NM) (SO) (RE)
CIRCLE 872

Siemens Corp.
Siemens Components Inc.
10950 N. Tantau Ave.
Cupertino, CA 95014
(408) 777-4542
(MF) (PI)
CIRCLE 873

Sierra West Power Systems
300 N. Telshor Blvd.
Suite 500
Las Cruces, NM 88001
(505) 522-8828
(50S) (51S) (500S) (10S)
(11S) (200S) (RM) (OF)
(CV) (RP) (MD) (UN) (PF)
(50C) (51C) (500C) (10C)
(11C) (200C) (DC) (AC)
(MO) (IC) (MI) (50R) (51R)
(500R) (10R) (11R) (200R)
(LI) (SW) (MU) (ID) (ML)
CIRCLE 874

Silicon Transistor Corp.
27 Katrina Rd.
Chelmsford, MA 01824
(508) 256-3321
(BT) (MF) (RE) (TH)
CIRCLE 875

Siliconix Inc.
2201 Laurelwood Rd.
Santa Clara, CA 95056
(800) 554-5565
(MF) (PI)
CIRCLE 876

Sola
1717 Busse Rd.
Elk Grove Village, IL 60007
(708) 439-2800
(50S) (10S) (11S) (RM)
(OF) (CV) (PF)
CIRCLE 877

Sorensen Co.
615 N. Railroad Ave.
Paxton, IL 60957
(217) 379-2171
(50S) (51S) (500S) (10S)
(11S) (200S) (LA) (RM)
(CV) (RP) (PF) (50C)
(200C) (DC) (MO)
CIRCLE 878

Speco/Emco Electronics
1172 Rt. 109
Lindenhurst, NY 11757
(516) 957-8700
(50S) (LA) (50C) (AC)
CIRCLE 879

Spellman High Voltage Electronics
7 Fairchild Ave.
Plainview, NY 11803
(516) 349-8686
(500S) (200S) (LA) (RM)
(OF) (CV) (RP) (PF) (DC)
(MO) (LI) (SW)
CIRCLE 880

Stanford Research Systems
1290-D Reamwood Ave.
Sunnyvale, CA 94089
(408) 744-9040
(500S) (11S) (LA) (RM)
(CV) (RP)
CIRCLE 881

Supertex Inc.
1350 Bordeaux Dr.
Sunnyvale, CA 94089
(408) 744-0100
(MF) (PI) (PC)
CIRCLE 882

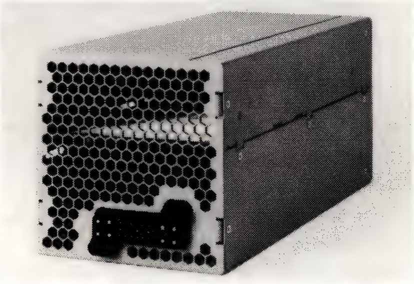
Switching Power Inc.
3601 Veterans Hwy.
Ronkonkoma, NY 11779
(516) 981-7231
(50S) (200S) (OF) (CV) (PF)
(50C) (200C) (DC) (50R)
(11R) (200R) (SW)
CIRCLE 883

Switching Systems Int'l.
500 Porter Way
Placentia, CA 92670
(714) 996-0909
(50S) (11S) (200S) (OF)
(PF) (50C) (11C) (200C)
(DC) (50R) (SW)
CIRCLE 884

(see p. 131 for key)
(continued on p. 130)

▼ ISOLATED FRONT END DRIVES CONVERTERS

The first in a family of power-factor-corrected, isolated front-end power supplies is available. The PM33210P delivers up to 2100 W in a compact 5-by-5-by-11.5-in. package with hot-swap Elcon Lower Drawer connectors. The supply's 48-V, 44-A output is well suited for driving dc-dc converters in distributed-power systems. The unit's wireless-programmed, droop current sharing allows for easy parallel operation in redundant architectures. Its true hot-swap capability, in which the ac input need not be cycled off during replacement, makes it a candidate for N+1 fault-tolerant applications. Active power-factor correction to better than 0.99 meets IEC 555-2 requirements. Prices start at $990 in single quantities. Delivery is from stock to four weeks.



Pioneer Magnetics
1745 Berkeley St.
Santa Monica, CA 90404
(310) 829-6751
▶**CIRCLE 615**

▼ VOLT-RESONANT IGBT CUTS POWER LOSSES

A voltage-resonant IGBT for use in voltage-resonant inverter circuits reduces power losses by 35% compared with conventional devices. The CT60AM-20 IGBT is rated for 1000 V/60 A and is packaged in the TO-3PL outline. It includes the fast-recovery, free-wheeling diode necessary in voltage-resonant inverter circuits. Primary applications are resonant-switch battery chargers, portable high-frequency welders, and microwave ovens. Pricing is $10 in lots of 100. Prototype quantities are from stock to six weeks.

Powerex
200 Hillis St.
Youngwood, PA 15697-1800
(412) 925-7272
▶**CIRCLE 616**

POWER-SOURCE MANUFACTURERS

Taltronics Corp.
Div. of Dimetrics Inc.
404 Armour St., P.O. Box 339
Davidson, NC 28036
(704) 896-8185
(50S) (51S) (10S) (11S)
(200S) (RM) (OF) (CV) (PF)
(50C) (51C) (11C) (200C)
(DC) (LI) (SW)
CIRCLE 885

Tamura Corp. of America
P.O. Box 892230
Temecula, CA 92589-2230
(909) 699-1270
(50S) (10S) (11S) (200S) (OF)
(RP) (UN) (PF) (50C) (51C)
(10C) (DC) (AC) (IC) (50R)
(11R) (200R) (LI) (SW) (MU)
CIRCLE 886

Tauber Electronics Inc.
4901 Morena Blvd., Suite 314
San Diego, CA 92117
(619) 274-7242
(UN) (AL) (CZ) (LC) (LT)
(ME) (NC) (NH) (NM) (SO)
(ZA) (ZC)
CIRCLE 887

Technology Dynamics Inc.
100 School St.
Bergenfield, NJ 07621
(201) 385-0500
(50S) (51S) (500S) (10S)
(11S) (200S) (LA) (RM) (OF)
(CV) (RP) (MD) (UN) (PF)
(50C) (51C) (10C) (11C)
(200C) (DC) (MI)
CIRCLE 888

Tecnetics
6287 Arapahoe Ave.
Boulder, CO 80303
(303) 442-3837
(50S) (51S) (500S) (10S)
(11S) (200S) (RM) (CV) (RP)
(MD) (UN) (PF) (50C) (51C)
(500C) (10C) (11C) (200C)
(DC) (MO) (MI) (50R) (51R)
(500R) (10R) (11R) (200R)
(LI) (SW) (ML)
CIRCLE 889

Telcom Semiconductor
1300 Terra Bella Ave.
Mountain View, CA 94039
(415) 968-9241
(DC) (PI) (PC)
CIRCLE 890

Texas Instruments Inc.
Literature Response Center
P.O. Box 172228
Denver, CO 80217
(800) 477-8924, ext. 4500
(50C) (DC) (50R) (LI)
(SW) (BT) (MF) (PI)
CIRCLE 891

The Vector Group Inc.
189 Horsham Rd.
Horsham, PA 19044
(215) 672-6702
(50S) (LA) (RM) (CV)
CIRCLE 892

Todd Products Corp.
50 Emjay Blvd.
Brentwood, NY 11717-4905
(516) 231-3366
(50S) (51S) (11S) (200S) (OF)
(CV) (RP) (UN) (PF) (50C)
(51C) (11C) (200C) (DC) (MO)
CIRCLE 893

Toko America Inc.
1250 Feehanville Dr.
Mount Prospect, IL 60056
(708) 297-0070
(50S) (10S) (11S) (200S)
(OF) (CV) (PF) (50C) (10C)
(DC) (AC) (50R) (10R) (LI)
(SW) (PC)
CIRCLE 894

Toshiba America
Electronic Components Div.
9775 Toledo Way
Irvine, CA 92718
(800) 879-4963
(500C) (LT) (BT) (MF)
(RE) (PI)
CIRCLE 895

Total Power International Inc.
418 Bridge St.
Lowell, MA 01850
(508) 453-7272
(50S) (10S) (11S) (200S) (OF)
(50C) (10C) (11C) (200C)
(DC) (MO) (IC) (50R) (10R)
(11R) (LI) (SW) (MU)
CIRCLE 896

Transistor Devices Inc.
85 Horsehill Rd.
Cedar Knolls, NJ 07927
(201) 267-1900
(50S) (51S) (500S) (11S)
(200S) (LA) (RM) (CV) (PR)
(RP) (MD) (UN) (PF) (50C)
(51C) (500C) (11C) (200C)
(DC) (AC) (MO) (MI) (50R)
(51R) (500R) (11R) (200R)
(LI) (SW) (MU) (ML)
CIRCLE 897

Tri Source Inc.
415 Howe Ave.
Shelton, CT 06484
(203) 924-7030
(50S) (51S) (500S) (10S)
(11S) (200S) (RM) (OF)
(CV) (MD) (UN) (PF) (50C)
(10C) (11C) (200C) (DC)
(MO) (MI) (50R) (51R)
(500R) (10R) (11R) (200R)
(LI) (SW) (MU) (ML)
CIRCLE 898

Tri-Mag Inc.
1601 N. Clancy Ct.
Visalia, CA 93291
(209) 651-2222
(50S) (51S) (10S) (11S)
(200S) (OF) (UN) (PF)
(50C) (51C) (10C) (11C)
(DC) (AC) (MO) (IC) (50R)
(51R) (SW) (MU)
CIRCLE 899

Tripp Lite
500 N. Orleans
Chicago, IL 60610-4188
(312) 329-1601
(50S) (51S) (200S) (RM) (CV)
(PR) (UN) (PF) (51C) (AC)
(51R) (200R) (SW)
CIRCLE 900

Ultralife Batteries Inc.
1350 Route 88 South
Newark, NY 14513
(315) 332-7100
(LT)
CIRCLE 901

Unipower Corp.
3900 Coral Ridge Dr.
Coral Springs, FL 33065
(305) 346-2442
(50S) (200S) (RM) (OF)
(PF) (50C) (200C) (DC)
CIRCLE 902

Unitrode Integrated Circuits
7 Continental Blvd.
Merrimack, NH 03054
(603) 424-2410
(50R) (51R) (10R) (LI) (SW)
(ID) (ML) (MF) (PI) (PC)
CIRCLE 903

Upsonic
29 Journey
Aliso Viejo, CA 92656
(714) 448-9500
(50S) (51S) (500S) (UN)
CIRCLE 904

Valor Electronics Inc.
9715 Business Park Ave.
San Diego, CA 92131-1642
(619) 537-2500
(50C) (10C) (DC)
CIRCLE 905

Varta Batteries Inc.
300 Executive Blvd.
Elmsford, NY 10523-1202
(914) 592-2500
(AL) (LC) (LT) (ME) (NC)
(NM) (SO) (ZA)
CIRCLE 906

Vicor Corp.
23 Frontage Rd.
Andover, MA 01810
(508) 470-2900
(50S) (51S) (CV) (MD) (PF)
(50C) (51C) (DC) (MO) (MI)
CIRCLE 907

Viking Industrial Products
729 Farm Rd.
Marlboro, MA 01752
(508) 481-4600
(50S) (51S) (10S) (11S)
(200S) (OF) (CV) (PR) (50C)
(51C) (10C) (11C) (200C)
(DC) (AC) (50R) (51R) (11R)
(200R) (LI) (SW)
CIRCLE 908

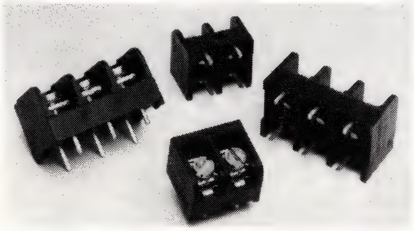
Voltex Co. Inc.
3460 Great Neck Rd.
Amityville, NY 11701
(516) 842-2772
(50S) (51S) (10S) (11S)
(200S) (OF) (CV) (RP) (PF)
(50C) (51C) (10C) (11C)
(200C) (DC) (LI) (SW)
CIRCLE 909

Wall Industries Inc.
5 Watson Brook Rd.
Exeter, NH 03842
(603) 778-2300
(50S) (10S) (11S) (200S)
(OF) (CV) (50C) (51C)
(500C) (10C) (11C) (200C)
(DC) (MO) (IC)
CIRCLE 910

(see p. 131 for key)
(continued on p. 131)

▼ TERMINAL BLOCKS FORGO MOUNTING SCREWS

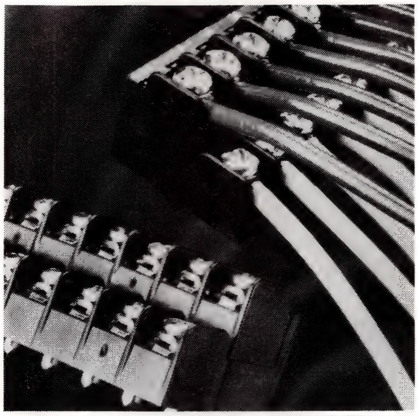
A double-pin configuration that eliminates the need for mounting screws is featured in the DBL Series of tri-barrier terminal blocks. The double-pin contacts enhance the integrity of the block-to-board connection and distribute the torque applied during termination and re-termination. The units have a continuous current capacity of 20 to 30 A and are UL- and CSA-recognized. They're available in lengths of two to six positions and cost about $0.25/position in lots of 1000. Call for delivery information.



Augat Inc.
452 John Dietsch Blvd.
P.O. Box 2510
Attleboro Falls, MA 02763
(508) 699-7646
▶ CIRCLE 617

▼ DUAL-HEIGHT BARRIER SAVES BOARD SPACE

A series of space-saving barrier terminal strips offers terminals on two levels. The Series 70 strips achieve greater circuit density. Wires on the strips' two levels don't interfere with each other, making access easy for wiring and disconnecting as needed. Rated at 20 A, the strips have terminals spaced on 0.325-in. centers. The dual-height feature achieves density of six circuits/inch. With four through 24 circuits, the strips stand 0.710 in. tall overall and are 1.13 in. wide. Pricing is $0.18/circuit in lots of 250. Delivery is in four weeks.



Beau Interconnect Systems Div.
Vernitron Corp.
P.O. Box 10
Laconia, NH 03247
(603) 524-5102
▶ CIRCLE 618

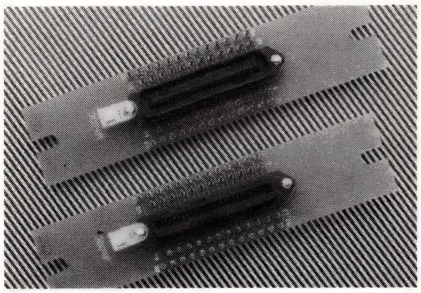
▼ UNIVERSAL ZIF SOCKET HANDLES SOICs, TSOPs

Over 50 different package sizes, including all SOICs and all TSOP Type II packages on 0.050-in. pitch, are accepted by one universal ZIF programming/test/burn-in socket. The socket accepts gull-wing and J-leaded devices with lead counts up to 44 and body widths from 0.15 to 0.60 in. No special tools are required for setup. In addition, the socket is adaptable for use with custom and hybrid devices by installing an insert plate in the socket base to provide chip location and replacing the pressure plate in the socket top with a simple custom plate. Pricing for the 44-547-11 socket is $140 in lots of 100.

Aries Electronics Inc.
P.O. Box 130
Frenchtown, NJ 08825
(908) 996-6841
▶ CIRCLE 619

▼ WIRE-WRAP ADAPTERS MAKE 50-PIN JUMP

A compact 50-pin connector-to-wire-wrap adapter comes with a front-mounted connector and wire-wrap pins mounted on a 0.092-in.-thick pc board with plated-through holes. The KG-3004 Series adapters is provided with solder mask to give maximum surface protection. Male or female connectors can be specified. The units measure 7 in. long by 1.6 in. wide by about 0.9 in. tall. Pricing is $29.95 in lots of 10.



K-G Devices Inc.
Box 81
DeWitt, NY 13214
(315) 455-7121
▶ CIRCLE 620

POWER-SOURCE MANUFACTURERS

Wayne Kerr/Farnell
11 Sixth Rd.
Woburn, MA 01801-1744
(617) 938-8390
(50S) (51S) (10S) (11S)
(200S) (LA) (RM) (CV) (RP)
CIRCLE 911

Wilson Greatbatch Ltd.
Electrochem Battery Div.
10000 Wehrle Dr.
Clarence, NY 14031
716) 759-6901
(LT)
CIRCLE 912

Xentek Inc.
1770 La Costa Meadows Dr.
San Marcos, CA 92069
(619) 471-4001
(50S) (11S) (200S) (RM)
(OF) (CV) (MD) (PF) (50C)
(10C) (11C) (200C) (DC) (IC)
(MI) (50R) (10R) (11R) (200R)
(LI) (SW) (ID) (ML)
CIRCLE 913

Yuasa-Exide Inc.
Stationary Battery Div.
P.O. Box 14145
Reading, PA 19612-4145
(215) 378-0333
(LC) (NM)
CIRCLE 914

Zenith Electronics Corp.
Power Supplies Div.
1000 Milwaukee Ave.
Glenview, IL 60025-2493
(708) 391-8510
(11S) (200S) (OF) (PF)
CIRCLE 915

KEY

Power Supplies

Output

(50S)	To 50 V
(51S)	51 to 500 V
(500S)	Over 500 V
(10S)	To 10 W
(11S)	11 to 200 W
(200S)	Over 200 W

Types

(LA)	Laboratory
(RM)	Rack mounting
(OF)	Open-frame OEM
(CV)	Constant voltage/ current
(PR)	Precision ac output
(RP)	Remote programming
(MD)	Military designs
(UN)	Uninterruptible
(PF)	Power-factor-corrected

Power Converters

Output

(50C)	To 50 V
(51C)	51 to 500 V
(500C)	Over 500 V
(10C)	To 10 W
(11C)	11 to 200 W
(200C)	Over 200 W

Types

(DC)	Dc to dc
(AC)	Dc to ac
(AT)	Ac to dc
(MO)	Modular
(IC)	IC DIP
(MI)	Military designs

Power Regulators

Output

(50R)	To 50 V
(51R)	51 to 500 V
(500R)	Over 500 V
(10R)	To 10 W
(11R)	11 to 200 W
(200R)	Over 200 W

Types

(LI)	Linear
(SW)	Switching
(MU)	Modular
(ID)	IC DIP
(ML)	Military designs

Batteries

Output

(AL)	Alkaline
(CZ)	Carbon zinc
(LC)	Lead acid
(LT)	Lithium
(ME)	Mercury
(NC)	Nickel cadmium
(NH)	Nickel hydrogen
(NM)	Nickel metal hydride
(SO)	Silver oxide
(ZA)	Zinc air
(ZC)	Zinc chloride

Power Semiconductors

Output

(BT)	Bipolar transistors
(MF)	MOSFETs
(RE)	Rectifiers
(TH)	Thyristors
(PI)	Power ICs
(PC)	Power-control ICs

▼ LED FLASHLIGHTS PROVIDE LOW LIGHT

Three compact flashlights use special LED lamps to provide color-controlled, low-intensity lighting in a variety of industrial and recreational applications. The Stealth-Lite is a wide-beam device whose light output won't interfere with night vision. The Specter-Lite is useful for professionals who must illuminate equipment or machinery while maintaining safe-light conditions. The Phantom-Lite is a pocket penlight that also doesn't interfere with night vision. All are made with a rugged, splash-proof anodized aluminum case. Three intensities are available as are eight visible colors and three infrared wavelengths. Call for pricing and delivery.

Ledtronics Inc.
4009 Pacific Coast Hwy.
Torrance, CA 90505
(310) 534-1505
▶ CIRCLE 644

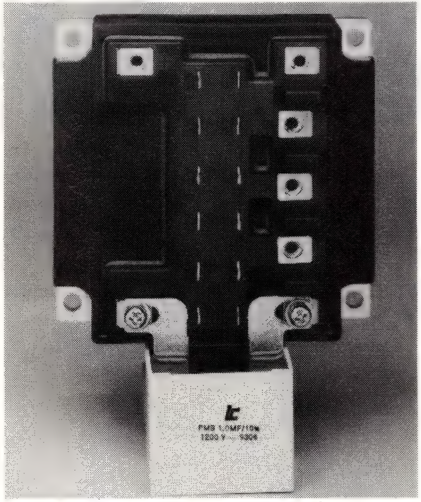
▼ SCREEN-PRINTED LAMPS BEST EL-FOIL TYPES

A screen-printed electroluminescent (EL) lamp boasts high performance and lower cost than EL foil lamps. The NovaLite lamps are built entirely on a screen-print table with no hand assembly. They offer extreme thinness (down to 12 mils), superior flexibility, and the ability to be made in virtually any shape. NovaLite lamps can be used in all typical EL applications, including backlighting of LCD, membrane switches, instrument clusters, clock and watch faces, copier and photographic erase functions, and safety signage. Power consumption is as low as 10 mA with a matched inverter circuit and the lamps generate no heat. Pricing is as low as \$0.20/in.^{2}. Call for delivery information.

ELtech
5524 Bee Caves Rd.
Building M
Austin, TX 78746
(512) 327-9801
▶ CIRCLE 645

▼ SNUBBER CAPACITORS MOUNT ON IGBT MODULES

A family of snubber capacitors developed for IGBT-module applications features mounting lugs that attach directly to the IGBT module's terminals. The PMB Series capacitors are constructed in a rectangular box package. Capacitance values range from 0.17 to 1.75 µF in voltage ranges from 850 to 1600 V dc. A major benefit is ease of mounting to the IGBT modules compared with leaded types. The mounting configuration also provides high reliability in vibration- or shock-prone situations. Call for pricing and delivery.



Illinois Capacitor Inc.
3757 W. Touhy Ave.
Lincolnwood, IL 60645
(708) 675-1760, ext. 727
▶ CIRCLE 646

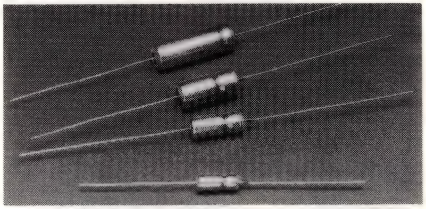
▼ SMT CHIP RESISTORS ARE PRECISION MOLDED

A line of precision-molded surface-mountable chip resistors offers performance characteristics similar to that of the company's S102 through-hole resistors. The SMR3 resistors use Vishay's Bulk Metal Foil resistive element to provide a very low temperature coefficient of resistance and excellent long-term stability (0.005% for 2000 hours). Other features include high moisture resistance, tight 0.01% tolerances, and low-noise operation. Values range from 5 Ω to 80 kΩ. Call for pricing and delivery.

Vishay Resistors
63 Lincoln Hwy.
Malvern, PA 19355
(215) 640-9081
▶ CIRCLE 647

▼ WET-TANTALUM CAPS MEET NEW MIL SPECS

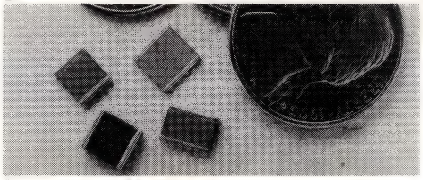
Two lines of wet-tantalum capacitors have electrical characteristics that meet two new, more stringent MIL specs. Both lines are distinguished by their low dissipation factor and high ripple-current capability. The CLR90 Series meets MIL-C-39006/30 and is available in values from 1.7 to 1200 µF. The CLR91 Series meets MIL-C-39006/31 for extended-range wet-tantalum capacitors. They range from 6.8 to 2200 µF. Both series feature rugged, all-tantalum, hermetically sealed cases. Four case sizes are available. Voltage ranges are from 6 to 125 V dc with reverse-voltage withstanding up to 3 V dc.



North American Capacitor Co.
7545 Rockville Rd.
Indianapolis, IN 46214
(317) 273-0090
▶ CIRCLE 648

▼ CERAMIC CHIP CAPS HANDLE HIGH VOLTAGES

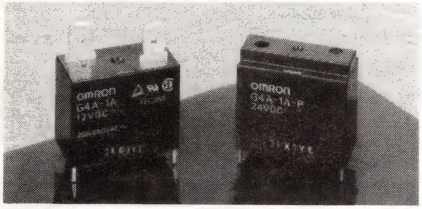
Three dielectric classifications, including the ultra-stable C0G, are available for the CHV Series of high-voltage, multilayer ceramic chip capacitors. The Class I C0G dielectric boasts negligible dependance of electrical properties on temperature, voltage, frequency, or time. The capacitors are available with voltages of 500 V dc and 1 kV dc with proof voltages of 1.5×rated volts. Capacitance values range from 3.9 pF to 1 nF in chip thicknesses from 1.6 to 2.5 mm. Prices range from \$0.055 to \$2.49 in lots of 1000. Delivery is from stock to 14 weeks.



Cal-Chip Electronics Inc.
15 Vincent Cir.
Warminster, PA 18974
(215) 672-5500
▶ CIRCLE 649

▼ MOTOR-CONTROL RELAY USES LITTLE PCB SPACE

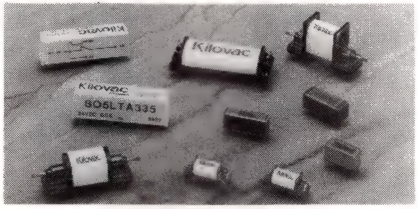
In response to requirements for downsizing pc boards, Omron has come up with its G4A motor-control relay, which is designed for high-inrush-current applications such as switching motors, compressors, and inverters. Contact ratings are 20 A and 250 V ac; 100,000 cycles resistive and 100-A inrush capability. The contacts are arranged as 1 Form A SPST-NO. Dimensions are 30.5 mm long by 16 mm wide by 23.5 mm high. Pricing starts at $5.30 with delivery from stock.



Omron Electronics Inc.
One E. Commerce Dr.
Schaumburg, IL 60173
(800) 556-6766
▶ CIRCLE 650

▼ SEALED REED RELAYS SWITCH HIGH VOLTAGE

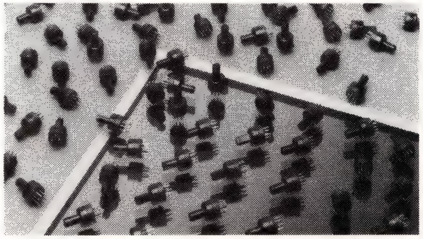
A line of vacuum-sealed, high-voltage, and RF power reed relays comprises 20 standard models, all suited for pcb mounting. The S Series runs from a 300-V, 2-A relay in a package measuring 1-1/8 in. long and less than 1/2 in.^{2} to a 10-kV, 5-A unit measuring less than 2-1/2 in. long and about 3/4 in.^{2}. The 10-kV model switches loads up to 500 W. Other key features include low contact resistance and high insulation resistance. Prices start at $20.50 for samples. Small lots are from stock.



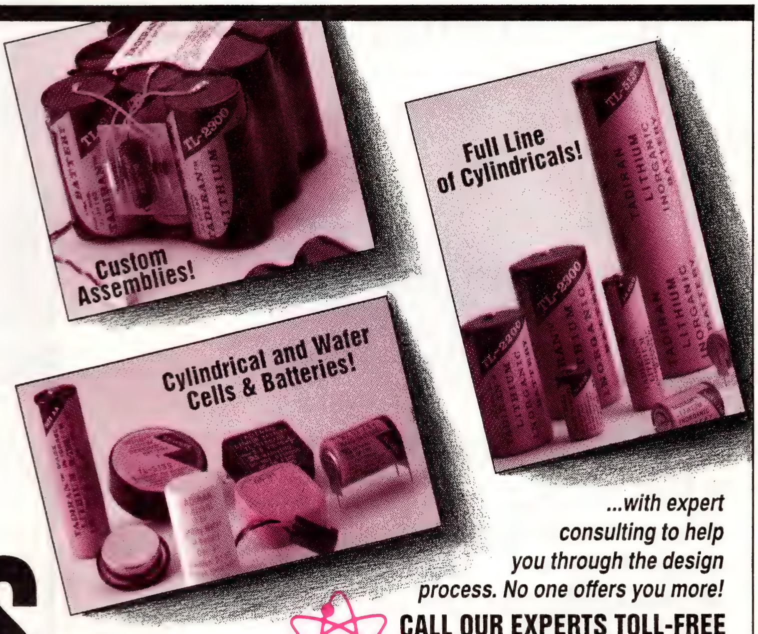
Kilovac Corp.
P.O. Box 4422
Santa Barbara, CA 93140
(805) 684-4560
▶ CIRCLE 651

▼ SUBMINI ROTARY SWITCH MOUNTS ON PC BOARDS

Gold-plated terminals and small size makes the TO5 rotary switch suited for pcb mounting. The low-profile 0.362-in.-diameter devices eliminate the need for jumpers or connectors. Their gold contacts ensure reliable switching over a long service life and handle 500 mA at a 125-V ac resistive load over the temperature range of –30 to 65°C. Available with screwdriver-slot or knob actuation, the switch features a 45° throw with a maximum of eight positions.



OakGrigsby
88 N. Dugan Rd.
Sugar Grove, IL 60554-0890
(708) 556-4200
▶ CIRCLE 652



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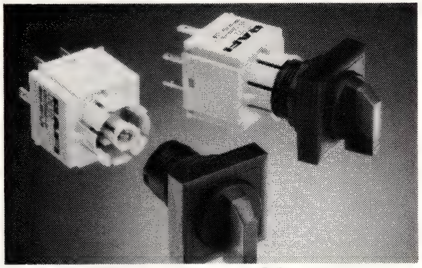
READER SERVICE 175

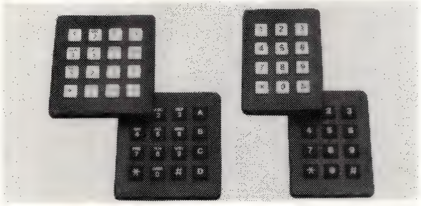
▼ LIGHTED SELECTOR FITS STANDARD PANELS



An 16.22-mm-diameter panel-mount unit and snap-on switch modules comprise the RAFIX 16 illuminated momentary or latching selector switch. The switch and lamp components install easily in panels. Water, cleansers, and lubricants are sealed out. Momentary or latching functions (normally open or closed) are available with contact ratings from 5 A at 250 V ac. Prices start at $25.17 in lots of 100.

C&K Components Inc.
57 Stanley Ave.
Watertown, MA 02172-4802
(617) 926-6400
▶CIRCLE 653

▼ RUBBER KEYPADS OFFER TACTILE FEEDBACK



A family of conductive-rubber keypads boasts a structure that ensures operator feedback. The Series 96 keypads incorporate switches rated for 3 million operations. Both 3-by-4 and 4-by-4 configurations are available. The housing that captures the rubber keypad and pc board carries a termination that mates with standard connectors. A 3-by-4 keypad with matrix code output costs $11 in single quantities and $5.94 in lots of 1000. Small lots are delivered in one to two weeks.

Grayhill Inc.
561 Hillgrove Ave.
LaGrange, IL 60525
(708) 482-2132
▶CIRCLE 654

▼ 20-W SS RELAYS NOW IN CERAMIC SIPs

Three single-in-line ceramic packages have been added to a line of optically isolated solid-state relays. The THR 120 060S, THR 070 200S, and THR 050 400S offer voltage ratings of 60, 200, and 400 V ac and steady-state current ratings of 12, 7, and 5 A, respectively. By substituting different power MOSFETs, however, voltage ratings of 60 to 1000 V ac and current ratings of 12 to 1 A may be obtained. In addition, maximum load current is quadrupled and on-resistance quartered when the relays are used in the dc parallel configuration. Applications include high-speed, high-power switching in industrial-control, power-management, and mechanical-relay replacement applications. Call for pricing and delivery information and for samples.

TH Electronics
97 Gannet Dr.
Commack, NY 11735
(516) 543-7161
▶CIRCLE 655

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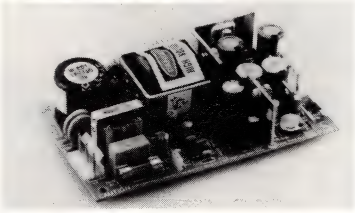

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READER SERVICE 166

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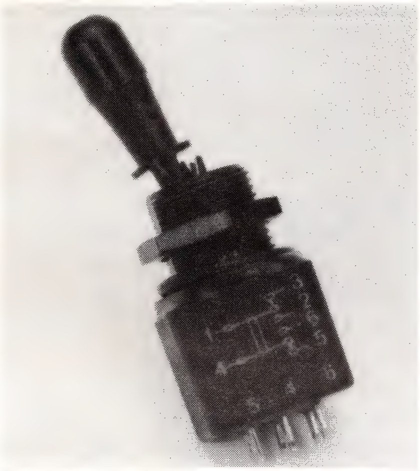
Wall Industries, Inc.
Tel: 603-778-2300
Fax: 603-778-9797
5 Watson Brook Rd.
Exeter, NH 03833

READER SERVICE 149

▼ TOGGLE SWITCHES MAKE EUROPE'S QPL

With a double-shell case for extra strength and insulation, the 12000X778 Series of toggle switches is QPL-listed in Europe. DPDT, three-pole double-throw, and four-pole double-throw types are offered in a wide variety of momentary and maintained two- and three-position configurations. Contacts are suited for ultra-low-level applications of 10 mA at 50 mV and 10 μA at 5 V dc minimum, or power applications of 2 A at 250 V ac, 4 A at 125 V ac, or 4 A at 30 V dc maximum. The double-pole model 12146-2VX778 with locking lever goes for $45.75 in lots of 1000.

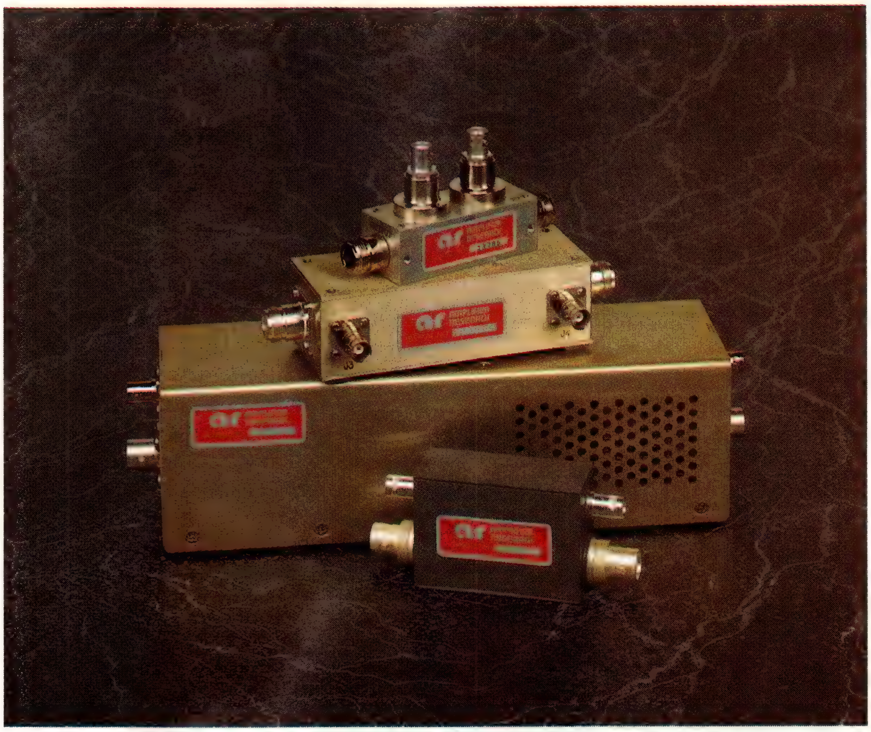


MORS/ASC
P.O. Box 544
Wakefield, MA 01880-4444
(617) 246-1007
▶CIRCLE 656

▼ MINI ROCKER SWITCH TAKES 200-A INRUSH

Rated for 12 A at 125/250 V ac, the Series 372 miniature rocker switches can reliably switch an inrush current of 200 A as specified in British Standard 415. The units, which carry many international safety-agency ratings, are well suited for use in switching power supplies where capacitive loads can generate inrush currents many times greater than the steady-state current. Designed with a snap-in panel-mount feature and 0.187-in. slip-on/solder terminals, the switch requires no additional mounting hardware.

ITW Switches
6615 W. Irving Park Rd.
Chicago, IL 60634
(312) 282-4040
▶CIRCLE 657



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Coupling factor	50 ± 1 dB	40 ± 0.6 dB	40 ± 0.6 dB	60 ± 1 dB	50 ± 1 dB	50 ± 1 dB	60 ± 1 dB	63 ± 1 dB
Directivity typical minimum	25 dB 20 dB	25 dB 20 dB	25 dB 20 dB	25 dB 20 dB	25 dB 20 dB	25 dB 20 dB	25 dB 20 dB	25 dB 20 dB
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9450

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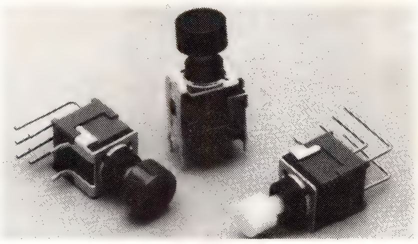
READER SERVICE 80

▼ TINY PUSHBUTTONS DEFANG STATIC CHARGES

An anti-static superstructure designed to shunt operator-induced static charges to ground is featured in the Series B super-subminature pushbutton switches. The anti-static design, coupled with the company's sliding twin-crossbar contact mechanism, ensures high operational integrity and an electrical and mechanical lifespan that exceeds industry standards. The switches are totally sealed to prevent contact contamination. As a result, they can be subjected to automated wave soldering and washing procedures during board assembly. All units are rated at 0.4 VA maximum at 28 V ac/dc maximum. Momentary and alternate-action models are offered. Various termination options are available, as are optional slip-on caps. Call for pricing and delivery.

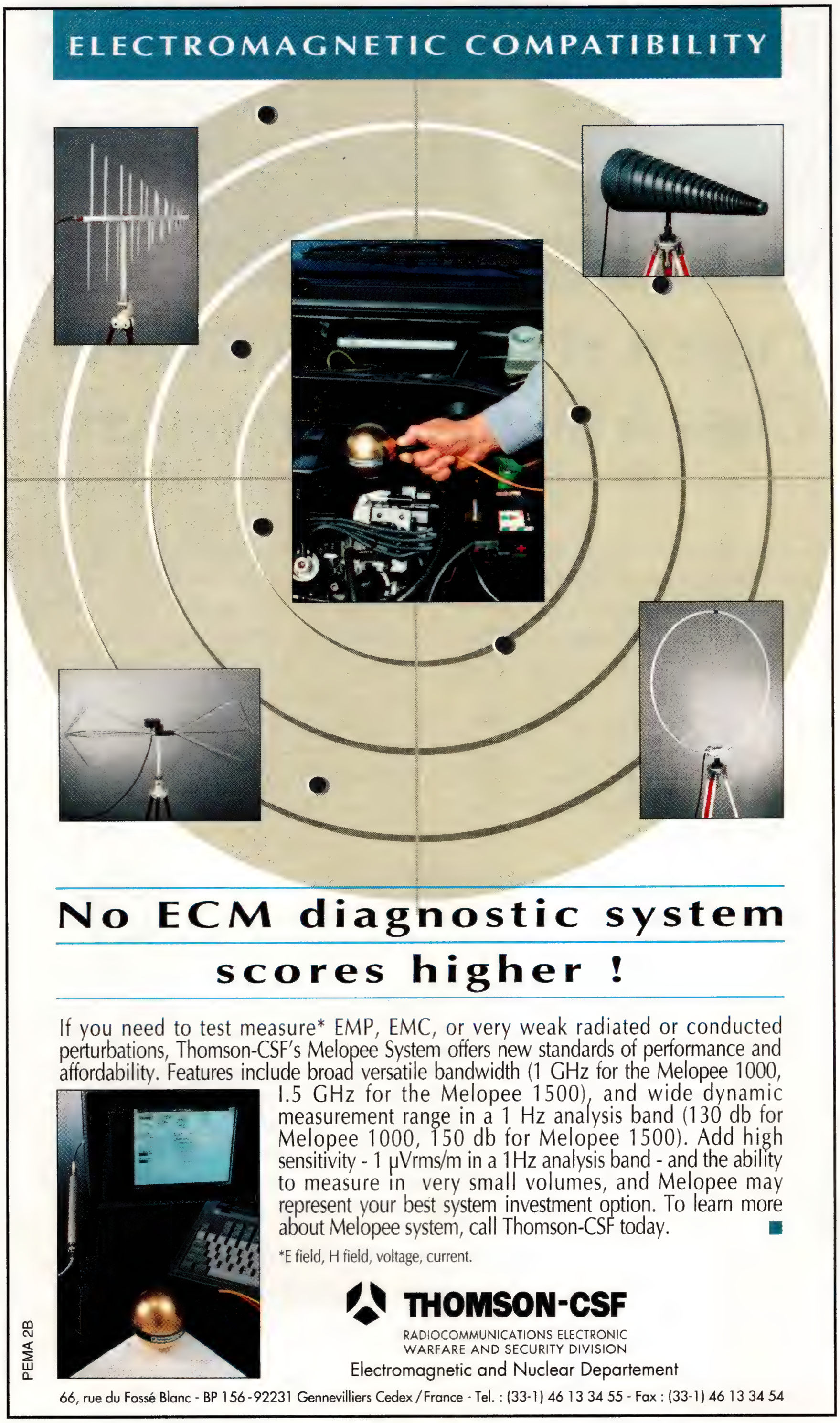


NKK Switches
7850 E. Gelding Dr.
Scottsdale, AZ 85260
(602) 991-0942
▶ CIRCLE 658

▼ LIGHTED ROCKERS BAR WATER AND DUST

A line of totally sealed (submersible), miniature rocker switches is now available with an illuminated function indication. The K Series switches withstand direct water spray and submersion to 10 feet, even during operation. Illumination can be incandescent, LED, or neon and in red, green, clear, or amber lenses. Seven circuit combinations are offered: two- and three-position, momentary and maintained operating modes, and one- or two-pole configurations. Illumination can be independent or dependent of the switch position, or a combination of both. Typical pricing for a single-pole, two-position, nonlighted switch is $4.20 in lots of 100. Delivery is from stock to six weeks.

Otto Controls
2 E. Main St.
Carpentersville, IL 60110
(708) 428-7171
▶ CIRCLE 659



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PEMA 2B

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CALL FOR PAPERS

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Electronic Design is soliciting technical papers to be presented at the Portable By Design Conference February 15-17,1995 in the Santa Clara Convention Center, Santa Clara, Calif.

Engineers experience in designing portable electronic systems of all types are invited to share their expertise. The range of eligible design applications includes computing, communications, data-entry, navigation and instrumentation-in either vertical and horizontal markets.

Papers should emphasize problem solving and provide insights into specifying and designing portable systems.

General topics to be covered include: Microprocessors and microcontrollers;Power Sources and circuits;Power management techniques; Batteries; Connectivity(e.g. docking, public wired network and all wireless); Software(e.g. operating systems including proprietary OS and application development); Peripherals (e.g. PCMCIA, GPS, storage); Displays; Input devices; industrial, medical, and test equipment; and, System design considerations (e g accelerated product development, testing, size, ergonomics, packaging, and ruggedness)

To participate, respond to this call for papers by sending a one-paragraph abstract of a paper you would like to present. Papers should be oriented toward solving specific design problems.

Abstracts should be sent to: *Program Chair, Portable By Design* Conference, c/o Electronic Design Magazine, P.O. Box 821, Hasbrouck Heights, NJ 07604. Or, send by fax to (201) 393-0204.

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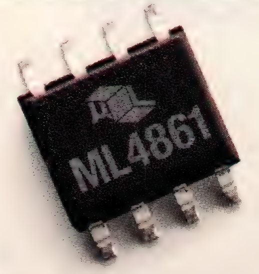

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Micro Linear

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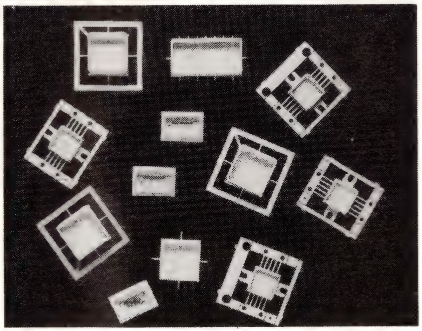
READER SERVICE 174

▼ MICROWAVE PACKAGES SUIT SMT NEEDS

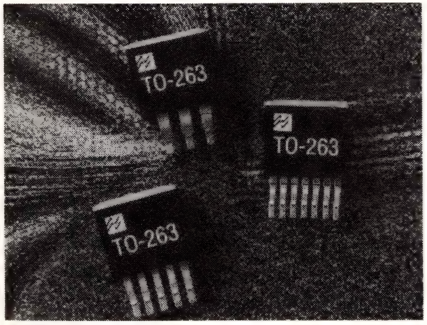
The VIA/PAK line of surface-mount ceramic packages is available for housing MIC and MMIC oscillators, amplifiers, mixers, and switches. Using thin-film processes, the packages are made on the company's VIA/PLANE substrates, available both in alumina and aluminum nitride. The substrate features hermetic tungsten-copper feedthroughs. Thin-film metalization is vacuum-deposited on the VIA/PLANE wafers in array format and photopatterned to achieve precise impedance control. After dicing, the individual substrates are assembled with seal rings and lead frames and brazed to form the package. Packages are offered in various sizes and lead configurations for performance up to 22 GHz. Lead time for new designs is eight to 10 weeks with tooling costs of $2000 to $4000.



Micro Substrates Corp.
2400 S. Roosevelt St.
Tempe, AZ 85282
(602) 731-6230
▶ **CIRCLE 660**

▼ SMT POWER PACKAGE IMPROVES ON 24-LEAD SO

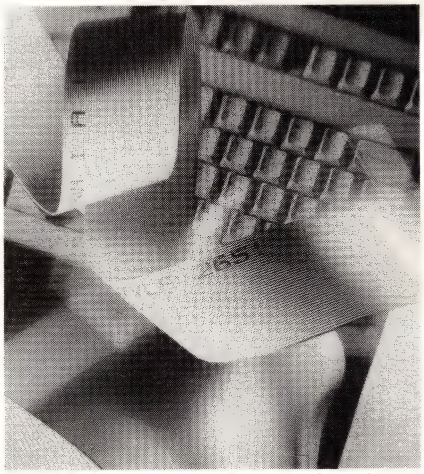
An alternative to the 24-lead, wide-body SO package for power devices delivers considerably more power and takes up 90% of the board space. The TO-263 is available in 3-, 5-, and 7-lead versions. It uses high-lead solder to attach the die to the paddle within the package, preventing the die-attach solder from reflowing due to exposure to the high temperatures seen during production. Initially, National plans to offer its Simple Switcher power converters and low-dropout regulators in the package. Registration for the TO-263 package as a JEDEC standard has been secured. Parts packaged in the TO-263 come in 500-piece tape-and-reel. Call for more information.



National Semiconductor Corp.
2900 Semiconductor Dr.
P.O. Box 58090
M/S 16.300
Santa Clara, CA 95052-8090
(408) 721-7509
▶ **CIRCLE 661**

▼ MINI RIBBON CABLE LINKS DRIVES TO PCs

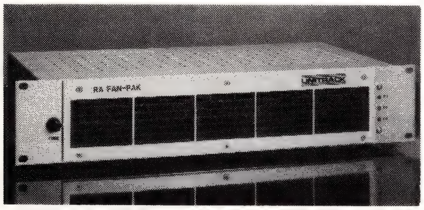
A 1-mm-pitch ribbon cable is particularly well suited for connections to disk drives using 2-mm IDC connectors. The 2L280XX cable requires less space, facilitates breakouts for circuit routing, and provides ample current-carrying capacity for these applications. It also meets the electrical-performance requirements specified for the SCSI-3 parallel interface. The gray extruded-PVC cable carries a black polarity stripe and operates at temperatures from –40 to 105°C. Conductors are stranded 28 AWG tinned copper and the cable is available with conductor counts of 26, 34, 40, 44, and 50. Other counts are available on request. Call for pricing and delivery.



Belden Wire & Cable Co.
P.O. Box 1980
Richmond, IN 47375
(800) 235-3364
▶ **CIRCLE 662**

▼ COOLING PACKAGE DISTRIBUTES 300 CFM

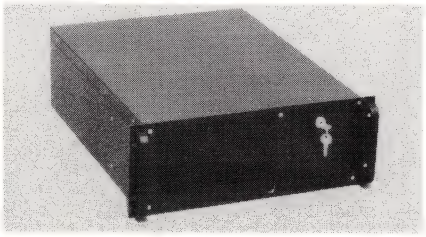
A cooling package brings 300 cfm of air through an enclosure's front panel and distributes it inside the unit. The system uses three quiet, long-life 115-V fans mounted in a sturdy aluminum case. It stands 2U (3-1/2 in.) high and fits into most standard cabinets. The standard Model RA comes complete with power line cord, fuse, and switch. Options include a washable air filter and an alarm circuit that visually indicates fan failure.



Unitrack Industries Inc.
967 E. Masten Cir.
Milford, DE 19963
(302) 424-5050
▶ **CIRCLE 663**

▼ SYSTEM ENCLOSURES OFFER RUGGEDNESS

The Series 1000 family of rack-mount/desktop enclosures for PC/AT/ISA-bus systems contains a switchable 115-/220-V ac, 300-W power supply and two front-mounted, positive-pressure fans with a removable, washable air filter. A 14-slot passive backplane, removable top cover, and pc-board retainer bar provide low repair times in industrial applications. The unit mounts up to three half-height drives and accepts two internally. Prices for Model 1010 (7 in. high by 21.5 in. deep by 19 in. wide) start at $1550 in lots of one to four with delivery from stock. Model 1020 (8.75 in. high by 19 in. deep by 19 in. wide) starts at $1650 and is available in four to six weeks.



Vector Electronic Co.
12460 Gladstone Ave.
Sylmar, CA 91342
(800) 423-5659
▶ **CIRCLE 664**

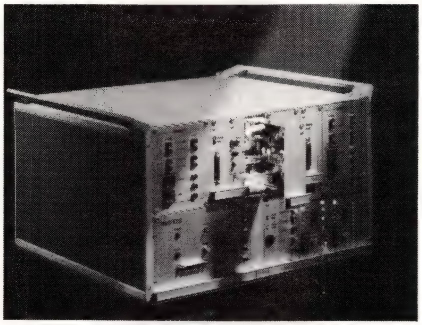
▼ SIX-SLOT CHASSIS SUITS EMBEDDED TASKS

Up to six full-length PC/AT cards can be housed in the Model 9060 chassis for embedded applications. Measuring 10.25 by 6.5 by 17 in., the unit features a card hold-down bracket that ensures that boards remain seated in high-vibration environments. With rugged 16-gauge steel construction, the chassis incorporates internal fans in both the card area and power supply for efficient cooling. The drive bay accepts up to three 3.5-in. drives with an option for up to five. Each drive is individually shock-mounted for rugged applications. There's also an option for two 5.25-in drives. Pricing is from $575 with delivery from stock.

Micro Computer Specialists Inc.
2598-G Fortune Way
Vista, CA 92083
(619) 598-2177
▶ **CIRCLE 665**

▼ INSTRUMENT CASES INTEGRATE CARD FRAME

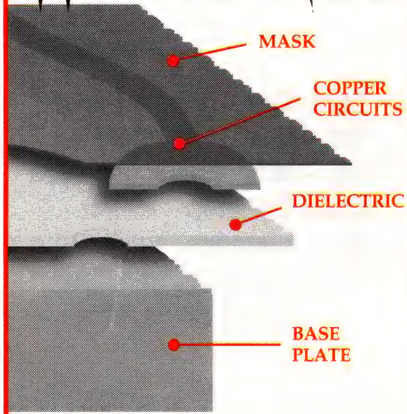
With the Vario-Module iS instrument case, users get several alternatives for configuration: a desk-top unit, a tower configuration, or a 19-in. rack-mounted enclosure. The standard design is a desk-top unit which accepts cross rails to accommodate front panels, pc boards, and cassette modules. The unit is easily converted into a 19-in. rack-mount enclosure with bolt-on flanges. A handle system allows for further customization, including using the handles as feet to convert the enclosure into a tower. Top and bottom panels are removable for easy access and maintenance. Call for pricing and delivery.



Rittal Corp.
3100 Upper Valley Pike
Springfield, OH 45504
(800) 477-4000
▶ **CIRCLE 666**

What's Hot

What's Not!



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READER SERVICE 169

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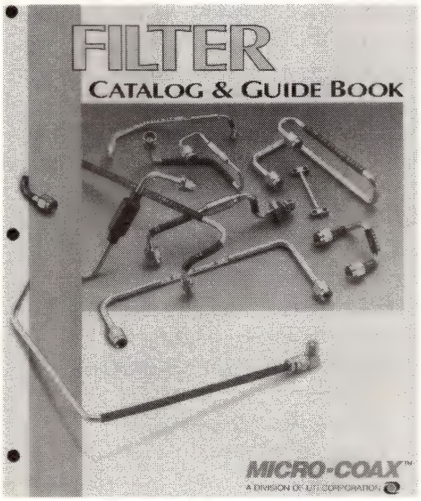
READER SERVICE 92

NEW LITERATURE

CATALOG DETAILS SPACE-SAVING FILTERS

Technical information, specifications, and application data on a line of filter products is contained within Micro-Coax's new catalog. The 38-page handbook describes the In-A-Cable filters, which combine Chebyshev and other filter types with semirigid or flexible cables to produce outstanding performance in the same space as the cable alone. The integration of filter, cable, and connector in a single assembly reduces parts counts which, in turn, results in smaller, lighter, and more reliable end products.



Micro-Coax
P.O. Box 993
Collegeville, PA 19426-0993
(610) 489-3700
▶ **CIRCLE 667**

LIGHTED PUSHBUTTONS MEET CONTROL NEEDS

A designer's guide to industrial lighted pushbutton switches covers the Series 90 environmentally rugged industrial and commercial four-lamp lighted switches and indicators. Each section of the 52-page guide gives detailed product information on pushbutton display attributes. These include LED or incandescent lighting, electrical switching characteristics, mounting, and optional features and accessories. The guide's easy-to-use format allows engineers to select the right switch for their application.

StacoSwitch Inc.
1139 Baker St.
Costa Mesa, CA 92626
(714) 549-3041
▶ **CIRCLE 668**

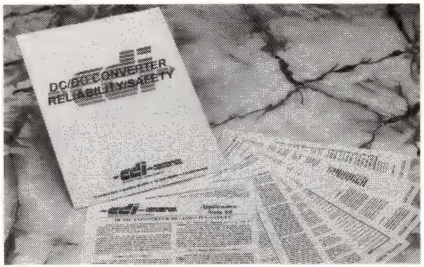
SHIELDING CATALOG COVERS THE BASICS

Basic EMI concepts, typical shielding applications, and EMI-gasket attachment systems are among the topics covered in a 40-page catalog of products for EMI shielding of commercial electronics. Details are included on a variety of EMI gaskets, foil tapes, foil/film laminates, and protection systems for cables.

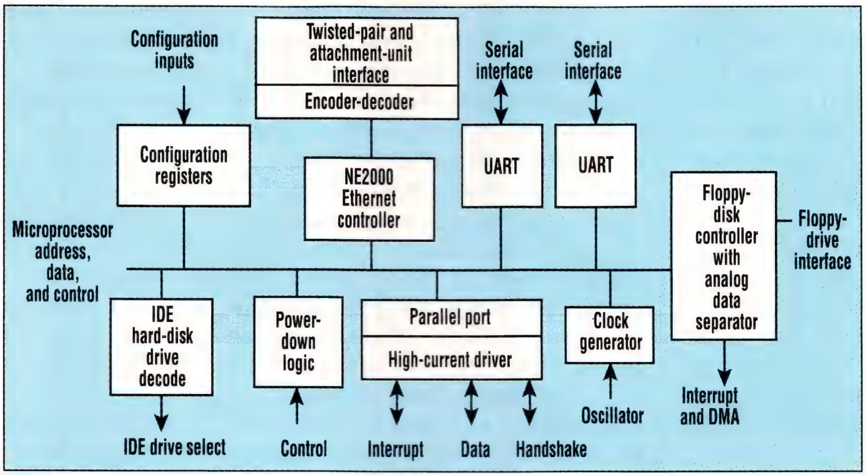
Chomerics Inc.
77 Dragon Ct.
Woburn, MA 01888
(617) 935-4850
▶ **CIRCLE 669**

CONVERTER APP NOTE COVERS RELIABILITY

A comprehensive application note on dc-dc-converter reliability and safety approvals is available. The eight-page note #4 provides information on topics such as MTBFs, how they're calculated, and how to use them; why burn-in is needed and what to look for; a review of all major agency safety approvals; a review of the different registration levels of ISO-9000; and a section on major military processing standards related to dc-dc converters. The note provides an overview of the fundamentals and suggests specific questions that designers can pose to vendors.



Conversion Devices Inc.
15 Jonathan Dr.
Brockton, MA 02401
(508) 559-0880
▶ **CIRCLE 670**



1. THE SUPER I/O+LAN CHIP INTEGRATES LAN capability with standard PC chip-set functionality. This includes a floppy-disk controller, two UARTs, a parallel port, an IDE interface, and a PLL.

NE2000 ETHERNET LAN CONTROLLER COMBINES WITH I/O CAPABILITIES IN A SINGLE CHIP FOR PC PLATFORMS.

PC CHIP SET INTEGRATES LAN FUNCTIONALITY

RICHARD NASS

Designers of PC platforms, looking to get higher levels of integration, now are moving as much of the I/O functionality as possible into the PC chip set. Today's state-of-the-art systems contain almost all of the I/O functionality that the system would require except for the graphics and LAN capabilities. With the introduction of the PC87340VUL Super I/O+LAN, however, even the LAN capability is included in the chip. As a result, all of the standard peripherals found on the ISA bus of a typical network-ready PC are integrated into the same IC. The chip, developed by National Semiconductor., includes a floppy-disk controller with an analog separator, two 16550 universal asynchronous receiver/transmitters (UARTs), a parallel port, and an IDE interface with DMA control logic *(Fig. 1)*. Basically, the part combines the company's predecessor Super I/O part with an NE2000 Ethernet controller. Bundling the two components together reduces both the required pc-board space and the system cost by eliminating an Ethernet add-in card. The chip is targeted toward desktop PCs and docking stations.

Besides the two components, National added an enhanced physical-layer interface, including filtering that had been external to the device in previous designs. The mixed analog/digital-megacell interface integrates the filters into the Ethernet 10BaseT functionality to further reduce cost. According to the chip's designers, the analog-filter design was the most challenging because of the mixed analog and digital circuitry. The receive filter suppresses unwanted noise without suppressing the signal, while the transmit filter produces a smooth sine-wave signal.

The Ethernet controller is configurable, suiting it for most Ethernet applications. The included network interfaces on the chip are supported through an external transceiver that's connected to the chip's attachment-unit interface (AUI) or twisted-pair ports. The on-board media-access-control (MAC) unit, the encoder-decoder (ENDEC), and the 10BaseT transceiver conform to the IEEE 802.3 LAN standard. The transceiver includes receiver, transmission, loopback, jabber, collision, heart-beat, and link-integrity blocks.

Four logical blocks comprise the ENDEC: a phase-locked loop (PLL), Manchester encoder and decoder, and a collision translator. The PLL generates the 10-MHz transmit clock signal for system timing. The Manchester encoder accepts non-return-to-zero (NRZ) data from the MAC, encodes it, and passes it to the differential transmit driver. The Manchester decoder receives the data from the transceiver, converts it to NRZ data, and passes it to the MAC. The collision translator alerts the MAC when there's a valid 10-MHz collision signal.

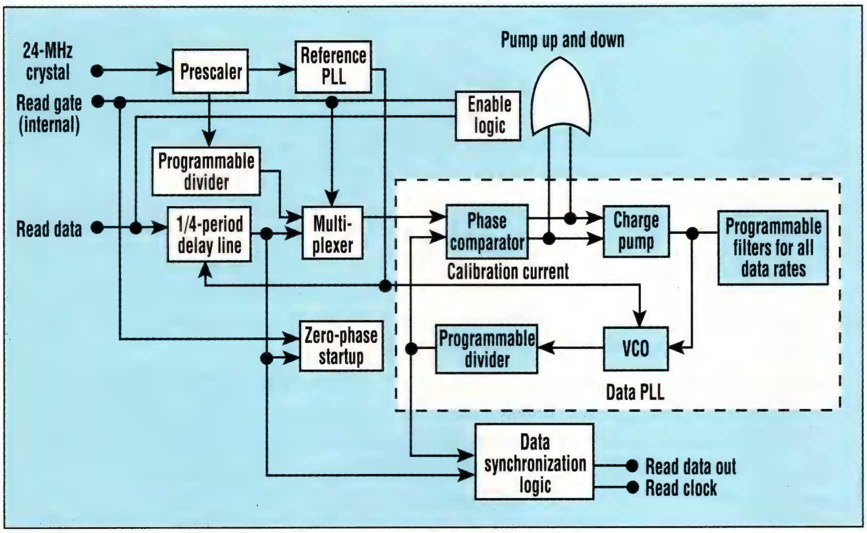
The floppy-disk-controller block can be used for PC/AT, EISA, and PS/2 buses, as well as general-purpose applications. It includes a 16-byte FIFO buffer, PS/2 diagnostic register support, a perpendicular recording mode, and a high-performance analog data separator (which consists of an analog PLL and associated circuitry).

The PLL synchronizes the raw data signal that's read from the disk drive. The signal separates the encoded clock and data pulses. The pulses are deserialized into bytes and sent to the host.

Five components make up the PLL: a phase comparator, a charge pump, a programmable filter, a voltage-controlled oscillator (VCO), and a programmable divider *(Fig. 2)*. The comparator detects the phase difference between the divider's output and the raw data coming from the disk. The charge pump converts the phase difference to a current, which charges or discharges one of three filters (the filter is selected on the basis of the data rate). The resulting voltage on the filter changes the frequency of the VCO and the divider output to reduce the phase difference between the input data and the divider's output. The PLL locks when the divider's frequency equals the average frequency of the data coming off the disk.

To help reduce the system's memory cost, designers of the Super I/O+LAN chip integrated SRAM on the device, yet still maintained NE2000 compatibility. The on-board SRAM also increases performance.

To ensure that most I/O accesses occur with zero wait states, the internal LAN controller operates at a clock rate of 40 MHz. Due to the architecture's higher efficiency, the part can run with just 6 kbytes of SRAM, down from the typical 16 kbytes used in NE2000-compatible systems. Software compatibility is guaranteed by incorporating a sophisticated memory-management and mapping system. The same set of transmit and receive buffer registers are presented to the driver software.



2. THE ANALOG DATA SEPARATOR HOLDS THE PLL, which consists of five components. The PLL synchronizes the raw data read from the disk drive, which is used to separate the encoded clock and data pulses.

In the PC87340VUL, the memory manager allows for variable-size buffer registers. Receive packets are stored in the receive buffer ring in a contiguous fashion, leaving no unused memory space between the packets.

A second function of the memory manager involves mapping the logical memory address to the physical memory address. The SRAM buffer is divided into transmit and receive units. On the transmit side, if the buffer falls into a lower address, it gets mapped directly to the physical address space. If it's located in an upper address, it gets shifted to the upper end of the physical memory. On the receive side, the remaining portion of the physical memory is used as the receive buffer. It also operates as a circular ring similar to its logical counterpart. But it's smaller and has a variable buffer size.

All address shifting and translating is handled automatically in real time. No modifications are required to the existing drivers. And, no special initialization sequence is needed.

An innovative dual-footprint layout with an inner and outer ring lets system designers build motherboards using either the predecessor 100-pin National Super I/O chip, or National's new PC87340VUL 160-pin Super I/O+LAN chip. As a result, the same motherboard can run in a networked or non-networked configuration just by swapping out the chip set. The PC87340VUL is pin-compatible with the predecessor Super I/O chip, except for the extra pins on the PC87340VUL needed for the LAN connection. ☐

PRICE AND AVAILABILITY

The PC87340VUL Super I/O+LAN sells for $23.50 each in lots of 10,000. Production quantities should be available this August.

National Semiconductor Corp., 2900 Semiconductor Dr., P.O. Box 58090, Santa Clara, CA 95052; (800) 272-9959. **CIRCLE 512**

HOW VALUABLE?	CIRCLE
HIGHLY	533
MODERATELY	534
SLIGHTLY	535

DATA BOARDS BECOME SWITCHLESS, JUMPERLESS

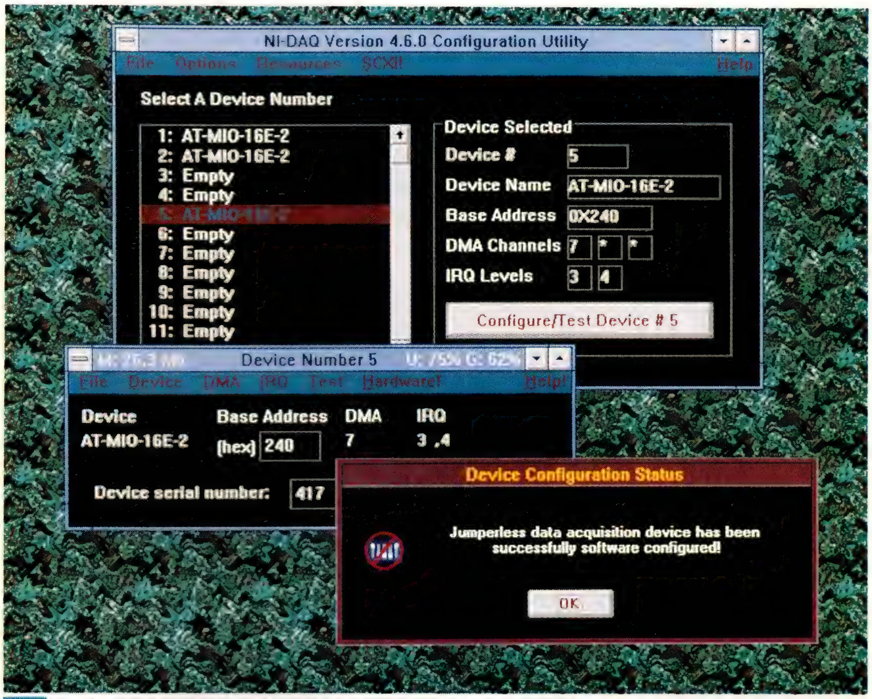
A PAIR OF CUSTOM ASICS MAKE THE E-SERIES DATA-ACQUISITION BOARDS COMPLETELY SOFTWARE CONFIGURABLE AND BOOST PERFORMANCE, TOO.

JOHN NOVELLINO

PC-based data-acquisition systems using plug-in boards generally can be a pain in the neck to set up. This fact hasn't hurt their growing popularity, though, as improved analog-to-digital conversion techniques and PC power make PC-based data acquisition an attractive solution in many test and measurement applications. Still, users would like to do away with the jumpers, switches, and potentiometers that are inherent to the setup and calibration of plug-in boards.

Now they can do just that with two multifunction analog, digital, and timing I/O boards for PC/AT and EISA-bus computers. The AT-MIO-16E-2 and AT-MIO-16XE-50 designed by National Instruments Corp., Austin, Texas, have no jumpers, switches, or potentiometers. All bus-related factors (base I/O address, interrupt, and DMA channels) and all data-acquisition characteristics (I/O range, polarity, gain, and mode) are software-programmable. The boards also have enhanced timing features.

The boards are the first of a family called the E-Series, which defines a new architecture for data acquisition. The complete software configurability is made possible by a custom ASIC, the DAQ-PnP. Another custom ASIC, the DAQ-STC, improves the timing specifications. The higher-performance unit, the 16E-2, also carries the NI-PGIA instrumentation amplifier, which is a custom daughterboard aimed specifically at data-acquisition


NI-DAQ Version 4.6.0 Configuration Utility
File
Options
Resources
SCXI!
Help
Configure/Test Device # 5
Device Number 5
File
Device
DMA
IRQ
Test
Hardware!
Help!
Device Configuration Status
OK

Select A Device Number

1: AT-MIO-16E-2
2: AT-MIO-16E-2
3: Empty
4: Empty
5: [illegible]
6: Empty
7: Empty
8: Empty
9: Empty
10: Empty
11: Empty

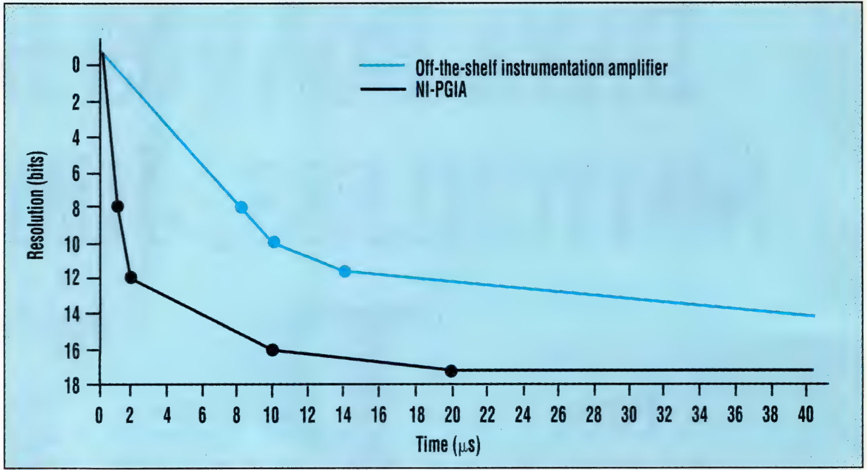
Device Selected
Device # 5
Device Name AT-MIO-16E-2
Base Address 0X240
DMA Channels 7 * *
IRQ Levels 3 4

Device	Base Address	DMA	IRQ
AT-MIO-16E-2	(hex) 240	7	3 ,4

Device serial number: 417

Jumperless data acquisition device has been successfully software configured!

1. A CONFIGURATION UTILITY ALLOWS users to setup and calibrate the E-Series ISA- and EISA-bus data-acquisition boards without the need for switches, jumpers, or potentiometers.



2. THE CUSTOM INSTRUMENTATION amplifier used on the AT-MIO-16E-2 board has a very fast settling time. As a result, users needn't reduce sampling rates to maintain signal fidelity.

applications. The E-Series boards even have a resettable fuse. Once the boards are plugged into the PC, they never need to be touched again.

The AT-MIO-16E-2 can be run with 16 single-ended inputs, 16 pseudo-differential inputs with a shared common line, or eight fully differential inputs. Sampling rate is 500 ksamples/s with 12-bit resolution at all gain settings. Other functions include two analog outputs with 12-bit resolution, eight TTL digital I/O lines that can sink 24 mA each, and two 24-bit counter-timer channels. Data transfers are accomplished using direct memory access, interrupts, or programmed-I/O capability.

Users can program the on-board gain to 1, 2, 5, 10, 20, 50, or 100, and the input range to ±10 V, 0 to 10 V, or ±5 V. The gain, polarity, and mode (single-ended or differential) is software-programmable on a per-channel basis. The board has full hardware-based analog and digital trigger capability. To ensure high throughput, the unit contains a 2048-word analog input FIFO buffer, a 2048-word analog output FIFO buffer, and dual-channel DMA, making it the first multifunction data-acquisition board with counter-timer DMA capability. Furthermore, using National Instrument's Real-Time System Integration (RTSI) bus, the board can share trigger and timing signals with other boards in the same computer.

The less expensive AT-MIO-16XE-50 differs from the 16E-2 primarily in digitizing rate (20 ksamples/s) and FIFO memory size (512 words). Also, the slower sampling rate makes the NI-PGIA unnecessary.

PLUG AND PLAY READY

Besides allowing jumperless and switchless operation, the DAQ-PnP ASIC fully implements the hardware requirements of the Plug and Play ISA Specification designed by Intel Corp. and Microsoft Corp., and is endorsed by more than 20 hardware and software vendors. The standard provides for resource arbitration and assignment through software.

Plug and Play boards are designed to request resources from the Play and Play Configuration Manager, which is software that's available from Intel or Microsoft. At boot up, the configuration manager receives all of the resource requests, compares those requests to the available resources, and assigns those resources as efficiently as possible. Plug and Play software can be installed as a device driver to convert an existing computer to the standard, or it can reside in the BIOS of new computers. No hardware is needed to convert existing computers.

The E-Series boards can be used in both Plug and Play and conventional PC/AT and EISA-bus computers. A software utility that comes with the boards is used to set the base address, DMA, and interrupt settings *(Fig. 1)*. Users should try to avoid conflicts with other boards in the system. If conflicts do arise, however, they can be resolved by changing the setting with the software.

The data-acquisition settings also are controlled by the software. In addition, the analog input and output sections employ an on-board voltage reference, software-controlled calibration digital-to-analog converters (DACs), and an internal wrapback multiplexer to eliminate manual calibration.

Enhanced analog and digital circuitry allow control of the run-time settings by the application software.

The custom timing controller on the E-Series boards, called the DAQ-STC, delivers enhanced functionality, lower cost, and lower power consumption than off-the-shelf counter-timer chips. The chip is designed specifically for data-acquisition use and has 10 counter-timers (twice that on the most popular off-the-shelf ICs) and 50-ns resolution (four times that of the most popular ICs). Four counter-timers control the analog inputs, four control the analog outputs, and two are up-down counter-timers available to users. Moreover, the counter-timers are double-buffered so users can change values while applications are running without any programming delays.

Internal timing is controlled by a 20-MHz source, but external clocking also is possible. With the DAQ-STC, users can trigger off a specific level on a repetitive waveform and delay succeeding conversions by as little as 50 ns. Consequently, repetitive signals can be digitized at a 20-Msample/s rate. So for repetitive signals, the limitation is no longer the ADC's sampling rate, but rather the analog input bandwidth of the board. In addition, the chip allows users to sample different channels at different rates.

SYSTEM SYNCHRONIZATION

Two synchronization methods are possible using the DAQ-STC. The chip synchronizes all combinations of analog input, analog output, and counter-timer functions on one board. For example, users can employ an external strobe to control the analog-to-digital conversion and to time-stamp the conversion using the general-purpose counter. When it's combined with the RTSI bus, the DAQ-STC can perform the same functions for several boards. Because of improved ASIC technology, the DAQ-STC's increased functionality is available at one-third the power consumption of off-the-shelf timing ICs.

A key component of the 500-ksample/s AT-MIO-16E-2 is the NI-PGIA software-programmable-gain instrumentation amplifier, which accurately amplifies a differential signal at the board's input and converts it to a single-ended output for the ADC. A common problem with commercially available instrumentation amplifiers is that they don't settle to the accuracy of the ADC when the board scans multiple channels at a high rate and high gain. Unsuspecting users may get erroneous data, and others may have to reduce the sampling rate to maintain accuracy at high gains.

The NI-PGIA, which was specifically designed for use with data-acquisition boards, overcomes this limitation by using a transconductance technique that produces a very fast settling time. The amplifier settles to 12-bit accuracy in less than 2 µs and to 16-bit accuracy within 10 µs *(Fig. 2)*. Also, the settling time and linearity are independent of gain, which can be programmed to eight levels, compared to the four levels of other amplifiers. The amplifier's common-mode rejection ratio is comparable to the best offered by conventional instrumentation amplifiers.

The E-Series boards come with NI-DAQ, National Instruments' library of data-acquisition functions for DOS and Windows applications. NI-DAQ has interfaces for more than eight programming languages, including custom controls for Visual Basic. The boards also are compatible with the company's application software for instrumentation, LabView and LabWindows/CVI for Windows, and LabWindows for DOS. ☐

PRICE AND AVAILABILITY

The AT-MIO-16E-2 costs $1595, and the AT-MIO-16XE-50 goes for $995. Both will be available from stock starting in mid August.

National Instruments Corp., 6504 Bridge Point Pkwy., Austin, TX 78730-5039; (800) 433-3488 or (512) 794-0100. **CIRCLE 511**

HOW VALUABLE?	CIRCLE
HIGHLY	530
MODERATELY	531
SLIGHTLY	532

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NOV 6
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PRODUCTS NEWSLETTER

66-MHz System Holds 11.8-In. Color LCD

A complete 66-MHz 486DX2-based PC and disk drives combine with an 11.8-in. 1024-by 768-pixel color TFT flat-panel display in the APF5000, from APF, Greer, S.C. Weighing 14 lbs., the compact package leaves a 9-in. footprint on the desktop. The system holds 32 Mbytes of DRAM and sends out crisp, 64,000-color graphics over a 32-bit local bus. The low-power LCD contributes to a total system power consumption of just 40 W. Other features include a 500-Mbyte hard-disk drive, a 3.5-in. floppy drive, and one Type II PCMCIA expansion slot. The operating temperature range is 0 to 40°C. Prices start at $9725. For more information, call APF at (803) 244-4416. *RN* **CIRCLE 672**

SCSI-2 Host Adapters Increase Performance

A family of SCSI host adapters designed for EISA, VL-Bus, and ISA systems raises the bar on performance, integration, and ease of use. The boards, from BusLogic Inc., Santa Clara, Calif., are built with the company's MultiMaster ASIC chip. The BT-747C bus-mastered fast SCSI-2 host adapter is for EISA bus systems. It sells for $449. A similar version, the 746C, eliminates the floppy-disk support and sells for $429. The 445C is aimed at VL-Bus systems and is priced at $279. The 440C, without floppy-drive support, costs $259. The 545C for the ISA bus costs $279. Products come bundled with the company's AutoSCSI installation and configuration utility. Call (408) 492-9090. *RN* **CIRCLE 673**

Super-VGA Comes To Portable Systems

Super-VGA graphics has been added to portable systems (like the 2000 Handbook computer from Gateway 2000 Inc.) that have a PCMCIA card slot but no VGA connector. The innovation comes from a SVGA card from New Media Corp., Irvine, Calif. With the card, subnotebook computer can use conventional monitors and a larger screen at home or in the office. The card is automatically recognized by the computer when inserted and the screen display moves to the monitor. It has full plug-and-play compatibilities and a small driver program that's installed on the host. When the card is removed, the screen switches back to the Handbook's own screen. The card, the first in a family of SVGA adapters in PCMCIA-card format, consumes about 180 mA when powered by 5-V PCMCIA interfaces. For custom applications, a power-saving mode drops standby power to under 5 mW. Single-unit card price is $349. Call Carl Perkins, (714) 453-0100. *DB* **CIRCLE 674**

Flash Vendors To Ensure Pins-Out Compatibilty

The 5-V standard for flash-memory design that has been fostered around the Am29Fxx family between Advanced Micro Devices Inc., Sunnyvale, Calif., and Fujitsu Ltd., Tokyo, Japan, has now been extended to include SGS-Thomson Microelectronics, Agrate, Italy. The 5-V only standard for flash-memory operation (read and store) provides the industry with a multisourced memory architecture that will allow designers to interchange devices without concerns about operating incompatibilities. The 5-V Am29Fxx families are fully hardware and software compatible with JEDEC standards and are easy to use, thanks to AMD's embedded algorithms that automate the erase and program operations on the chip. These features will be carried over by SGS-Thomson as it introduces its 5-V family of compatible flash memories. SGS and AMD will work together to develop versions of the flash memories that will operate from 3-V supplies. Call AMD at (408) 732-2400 or SGS-Thomson at (617) 259-0300. *DB* **CIRCLE 675**

SCSI Terminator Packs Logic-Based Disconnect

With the ability to disconnect from the SCSI bus with a single logic control signal, the REG5601 active terminator from Burr-Brown, Tucson, Ariz., keeps all output lines in a high-impedance state without any applied power. In addition, each data line is individually clamped to ground to dissipate negative-going glitches. The 18-line active terminator meets all SCSI-2 requirements and includes on-chip resistors, as well as the 2.9-V regulator to provide the prescribed 110-Ω termination for low-power dissipation and high-speed data transmission. An alternate source for the popular 5601 terminator, the REG5601 includes a thermally protected regulator, a power-down mode that drops current to 150 μA maximum, and an output capacitance in the disconnect mode of just 10 pF typical. In a 28-lead surface-mount package, it sells for $4.60 in lots of 10,000. It's available from stock. Contact Bonnie Baker, (602) 746-1111. *DB* **CIRCLE 676**

Edited by Clifford Meth

CALL FOR PAPERS

The Portable By Design Conference and Exposition

Sponsored by Electronic Design Magazine

Electronic Design is soliciting technical papers to be presented at the Portable By Design Conference February 15-17,1995 in the Santa Clara Convention Center, Santa Clara, Calif.

Engineers experience in designing portable electronic systems of all types are invited to share their expertise. The range of eligible design applications includes computing, communications, data-entry, navigation and instrumentation-in either vertical and horizontal markets.

Papers should emphasize problem solving and provide insights into specifying and designing portable systems.

General topics to be covered include: Microprocessors and microcontrollers;Power Sources and circuits;Power management techniques; Batteries; Connectivity(e.g. docking, public wired network and all wireless); Software(e.g. operating systems including proprietary OS and application development); Peripherals (e.g. PCMCIA, GPS, storage); Displays; Input devices; industrial, medical, and test equipment; and, System design considerations (e g accelerated product development, testing, size, ergonomics, packaging, and ruggedness)

To participate, respond to this call for papers by sending a one-paragraph abstract of a paper you would like to present. Papers should be oriented toward solving specific design problems.

Abstracts should be sent to: *Program Chair, Portable By Design* Conference, c/o Electronic Design Magazine, P.O. Box 821, Hasbrouck Heights, NJ 07604. Or, send by fax to (201) 393-0204.

Deadlines:

Abstracts: October 10,1994

Full Papers: December 1,1994

40-MHz Video Fader Eases Design Of Gain-Control Circuitry

Two integrated circuits provide easy gain adjustment of signals from dc to 40 MHz. According to Linear technology, the LT1251 and LT1256 are the first ICs to use two current feedback input stages driving a pair of multipliers for gain control.

A single dc input voltage linearly fades the output signal between the two inputs. Linear Technology's intention, here, was to make the integrated circuit equivalent of a fader potentiometer.

The LT1251/LT1256 control circuit both sets the gain of the multipliers and keeps the gain constant with temperature. The output stage of these parts is optimized for driving coaxial cables and other difficult loads.

A single control voltage (0 to 2.5 V) varies the gain of one input stage between 0% and 100%, while the gain of the other input stage goes from 100% to 0%. With two input signals, the result is a smooth dissolver or fade from one to the other. When only one input is applied, the result is 1% accurate gain control.

The current-feedback architecture of the circuits results in wide bandwidth (40 MHz) for gains of one to ten, excellent linearity (0.001% distortion), and outstanding signal-to-noise of 80 dB referenced to 1 V for a 5-MHz bandwidth.

The LT1251 and LT1256 are complete video-fader solutions that come in 14-pin packages. They require only feedback resistors and control signals while operating on any power supply from a single 5-V supply to ±15 V. The LT1251 has special circuitry optimizing it for fader applications while the LT1256 is optimized for gain-control tasks.

The LT1251 and LT1256 are supplied in 14-pin plastic DIP and 14-pin SOIC packages. Pricing in lots of 1,000 is $5.76 in DIP, $6.06 in an SOIC. Devices are available from stock to 60 days after receipt of order.

***Linear Technology Corp.**, 1630 McCarthy Blvd., Milpitas, CA 95035-7487; (408) 432-1900.* **CIRCLE 622**

■ *CLIFFORD METH*

Linear-Active Filters Drop Noise For 16-Bit ADCs

The most demanding data-acquisition applications are served by the Series D68, 828, and 858 fixed-frequency and programmable linear-active filters. The devices can provide –100-dB attenuation for noise and distortion floors low enough to satisfy 16-bit a-d converters.

The filters all take advantage of the company's proprietary circuit designs using surface-mount technology. As a result, engineers can incorporate high-precision, reduced-footprint, low-profile filters into boards and systems where both performance and space are critical considerations.

All of the transfer functions and advantages of the previous eight-pole, linear active filters are offered in an extremely small, off-the-shelf package.

Profiles as low as 0.3 in. allow easy assembly into high-speed, multichannel, stacked-board instrument and system configurations.

Low-pass filters with –100-dB attenuation include Butterworth, Bessel, elliptic, and constant-delay transfer functions. Butterworth and elliptic filters are also offered in high-pass versions.

Cascading high-pass and low-pass filters permit construction of bandpass and notch filters in less space than before.

The D68, 828, and 858 filters serve a wide variety of data-acquisition needs. Individually in automatic test equipment, research and development, MRI, and electronic OEM applications, or in multichannel computer, sonar, VME, and VXI systems, the filters make it possible to double the filter density over other solutions.

Fixed-frequency D68 filters are available with preset corner frequencies from 10 Hz to 100 kHz. Single devices cost $151, with prices dropping to $120 in lots of 1000 or more.

The digitally programmable 828 and 858 filters offer a choice of preset tuning ranges as well as 8-bit (256-step) custom ranges to 101.4 kHz. Prices for the 828 filters start at $410 and decline in price to $295 in quantites of 100. The 858 models start at $385 and drop to $275 in similar quantities.

***Frequency Devices Inc.**, 25 Locust St., Haverhill, MA 01830; Greg Anderson, (508) 374-0761.* **CIRCLE 623**

■ *DAVID MALINIAK*

Op Amp Device For Capacitive Loads

The first JFET input operational amplifier optimized for driving large capacitive loads, the LT1457 is a dual C-Load op amp designed to handle at least 10,000-pF capacitive loads without oscillating. Applications for the device include sample-and-hold amplifiers, analog-to-digital and digital-to-analog converters, photodiode amplifiers, and voltage-to-frequency converters.

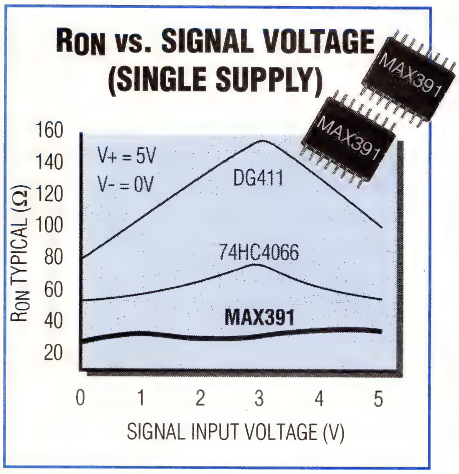
According to Linear Technology, precision specifications of the LT1457.include the industry's lowest maximum-input offset voltage for a dual JFET op amp: 450 μV in a plastic dual-in-line package, and 1200 μV in an SO-8 package. Input bias current is 50 pA of over the 0 to 70°C operating range. Voltage noise of the device is only 13 nV/Hz. The slew rate of the LT1457 is 4 V/μs. Offset drift is 4 μV/°C.

The LT1457 JFET input C-Load op amp is supplied in 8-pin dual in-line package, or 8-lead SOIC packages. Pricing, starting in lots of 1,000, is $2.32 in a DIP; $2.46 in an SOIC. Small quantities of the device are available now. CM

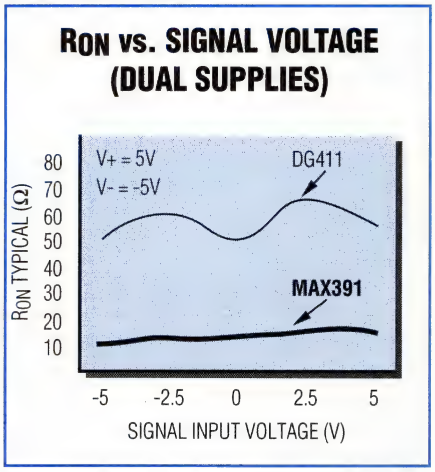
Linear Technology Corp., 1630 McCarthy Blvd., Milpitas, CA 95035-7487. **CIRCLE 641**

THE ONLY +5V CMOS SWITCHES WITH GUARANTEED 6Ω RON FLATNESS!

2Ω Max. Channel-to-Channel Matching



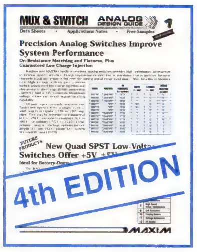
The new MAX391/MAX392/ MAX393 quad CMOS SPST switches are fully specified for +5V and ±5V operation. With 2Ω max RON matching, 6Ω max RON flatness, and 0.5μW power consumption, these switches are ideal for low-voltage, high-accuracy data acquisition and audio signal routing applications. All switches are pin-compatible with industry-standard devices and operate over a wide +3V to +15V or ±3V to ±8V supply range.



Low-Voltage Switches Offer Improved Parameters!

Device*	RON (Ω) max	ΔRON Match (Ω) max	RON Flatness (Ω) max	Leakage (pA) max	Charge Injection (pC) max	tON (ns) max	tOFF (ns) max
±5V Operation							
MAX391 Quad, SPST, NO	30	2	4	100	5	130	75
MAX392 Quad, SPST, NC	30	2	4	100	5	130	75
MAX393 Quad, SPST, 2-NO,2-NC	30	2	4	100	5	130	75
+5V Operation							
MAX391 Quad, SPST, NO	60	2	6	100	5	130	50
MAX392 Quad, SPST, NC	60	2	6	100	5	130	50
MAX393 Quad, SPST, 2-NO,2-NC	60	2	6	100	5	130	50

NO = Normally Open, NC = Normally Closed



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HALF-SIZE SBC CONNECTS TO PC/104

The Viper803 is an example of the trend toward single-board computers (SBCs) increasing in functionality while reducing their size. It holds a 486DX2 microprocessor on a half-size PC/AT board, making it suitable for such embedded applications as video conferencing, portable diagnostic equipment, and mobile vehicle tracking systems.

The Viper803 employs a PC/104 mezzanine interface, so users can expand or customize the board. Modules are available from a host of third-party suppliers, including communications devices, memory, I/O, and PCMCIA.

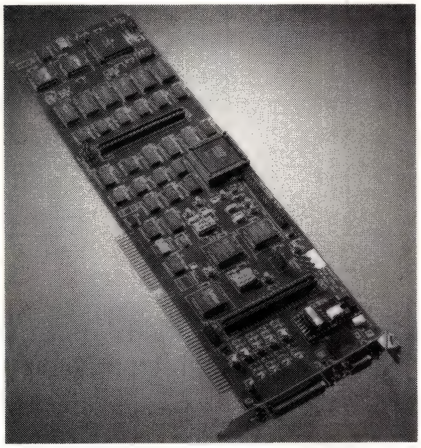
The board can either be plugged into a passive backplane or operate in a stand-alone configuration. It comes with a Chips & Technologies 65535 video controller for CRTs and flat-panel displays. On-board I/O functions include IDE, keyboard and floppy-disk controllers, as well as one parallel and two serial ports. Up to 16 Mbytes of DRAM fit on the board in addition to 1 Mbyte of bootable flash EPROM and 1 Mbyte of SRAM to form a solid-state disk. The Viper803's BIOS is user programmable without removing the card from the system. Prices start at $1195 for a system with a 25-MHz 486SX CPU. Large-volume discounts apply.

***Teknor Microsystems Inc.**, P.O. Box 455 Sainte-Therese, Quebec, Canada J7E 4J8; (514) 437-5682.* **CIRCLE 624**

■ *RICHARD NASS*

66-MHZ DSP BOARD FITS PCI BUS

Designed to fit the PCI or ISA buses, the Eagle-56 is a DSP board that's based on a 40- or 66-MHz Motorola DSP56002 processor. Offering a performance rating of 33 MIPS, a high-speed 16- and 24-bit parallel interface, and two 16-bit Codecs, the board is aimed at such applications as speech processing, digital audio, and multimedia. The processor features six independent functional units that can execute up to six operations per instruction. A phase-locked loop lets the processor use external clocks for full-speed operation while supplying an output clock that's synchronized to a synthesized internal core clock. The on-board zero wait-state SRAM is divided into four banks. The 40-MHz Eagle-56 board costs $2695, while the 66-MHz model sells for $3695. A Windows debugger, loader, and test utilities are included. RN



Momentum Data Systems Inc., 1520 Nutmeg Pl., Suite 108, Costa Mesa, CA 92626; (714) 557-6884. **CIRCLE 625**

FRAME GRABBER FITS PCI LOCAL BUS

The Comet is a frame-grabber board for PCI. The color and monochrome device offers a Super VGA and live video capability. The Comet can be used to build systems for identification and security, traffic or process control, product or food inspection, color verification, or medical visualization. Other features of the board include an optional RGB-monochrome capture module that can grab three inputs simultaneously, NTSC and PAL acquisition, and a 2-Mbyte frame buffer. Available now, the Comet frame-grabber board is priced at $795. RN

Matrox Electronic Systems Ltd., 1055 St. Regis Blvd., Dorval, Quebec, Canada H9P 2T4; (514) 685-2630. **CIRCLE 626**

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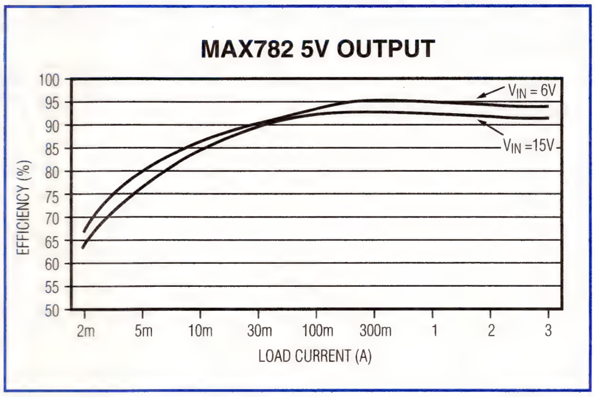

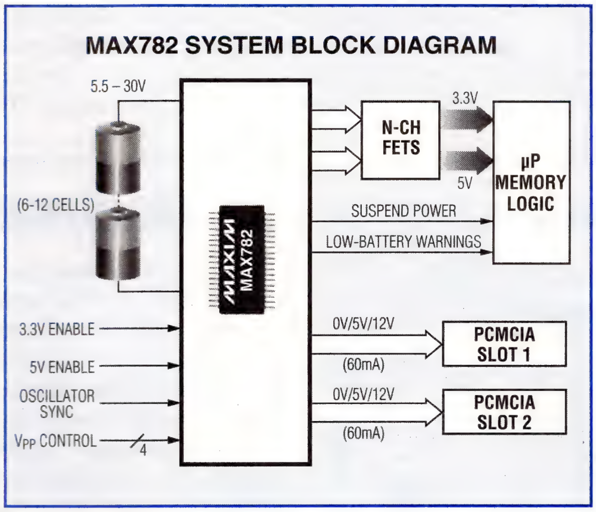

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SOFTWARE LINKS LOGIC AND PHYSICAL DESIGN

The EDAnavigator family of software for pc boards and multichip modules (MCMs) moves physical design, post-layout analysis, and manufacturing issues up front in the design cycle. This helps engineers make better design decisions early on, which reduces the number of iterations and accelerates time-to-market. EDAnavigator makes tradeoffs both automatically and interactively between electrical, thermal, routability, and other metrics, much in the same way that logic synthesis trades off between circuit area and speed. The product suite includes design advisors, an advisor backplane, an arbitrator, the partition compiler, a parametric placement capability, and the design explorer. The architecture of the backplane allows for concurrent execution of multiple advisors. The arbitrator evaluates the relative merit of design choices with respect to user-selected critical design metrics. Design explorer is a set of floorplanning, physical-partitioning, and placement functions. The EDAnavigator tools, which run on Unix workstations, will ship in the fall. Pricing ranges from $10,500 to $45,000, depending on configuration. LM

Harris EDA Inc., 7796 Victor-Mendon Rd., Fishers, NY 14453; (716) 924-9303. **CIRCLE 627**

LOW-COST SPICE TOOL DOESN'T LIMIT SIZE

ICAP/4Lite is a low-cost analog and mixed-signal circuit-simulation system from Intusoft. Most other low-cost Spice tools provide the traditional range of Spice analyses and elements, but limit the circuit size that can be simulated. Intusoft has taken a different route with ICAP/4Lite, which allows for unlimited circuit size but with a reduction in features. This was done in hope of creating an entry-level system that's both easy to use and cost effective. ICAP/4Lite performs the following analyses: ac (frequency response), dc (sweeps and operating point), transient (nonlinear time domain), and temperature (with both global and individual element variations). In addition, the system includes an integrated schematic-entry program that produces a complete Spice net list. ICAP/4Lite consists of schematic entry, the IsSpice4 simulator, and the IntuScope waveform-display utility. A library of over 500 parts is also included. Users may add optional model libraries or a post-processing program. Product support includes a free modeling service, a CompuServe BBS, and a Spice newsletter. ICAP/4Lite is a 32-bit system using Win32s extensions that runs under Windows and Windows NT. Pricing is set at $445. LM

Intusoft, P.O. Box 710, San Pedro, CA 90733-0710; (310) 833-0710. **CIRCLE 628**

COMPONENT INFO SYSTEM AIMS AT GLOBAL SETUP

The newest version of the Component Information System (CIS) from Aspect Development, called Enterprise CIS, aids manufacturers who are re-engineering business processes for their global operations. Enterprise CIS has an open, distributed client-server architecture that allows for multiple servers. Servers are connected via wide-area and local-area networks, and any server can be designated as a master version of the CIS. The data in all other servers is updated in accordance with the master. Enterprise CIS runs on almost all Unix platforms. A Kanji version of the product is available for Japanese users. In addition, Enterprise CIS links to Elisnet, a Japanese-language reference database for electronic components manufactured in Japan. For European customers, Aspect has integrated a reference database for electronic components that meet the quality standards of European government and industry. Enterprise CIS is integrated with many schematic-capture tools and library-management systems. Delivery is 30 days after receipt of order. Call the company for pricing. LM

Aspect Development Inc., 1240 Villa St., Mountain View, CA 94041; (415) 428-2700. **CIRCLE 629**

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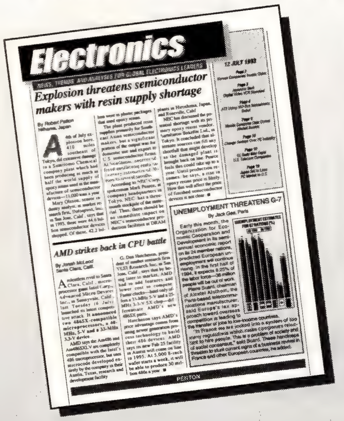
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DUAL SERIAL 12-BIT DAC CUTS SPACE & COST 35%

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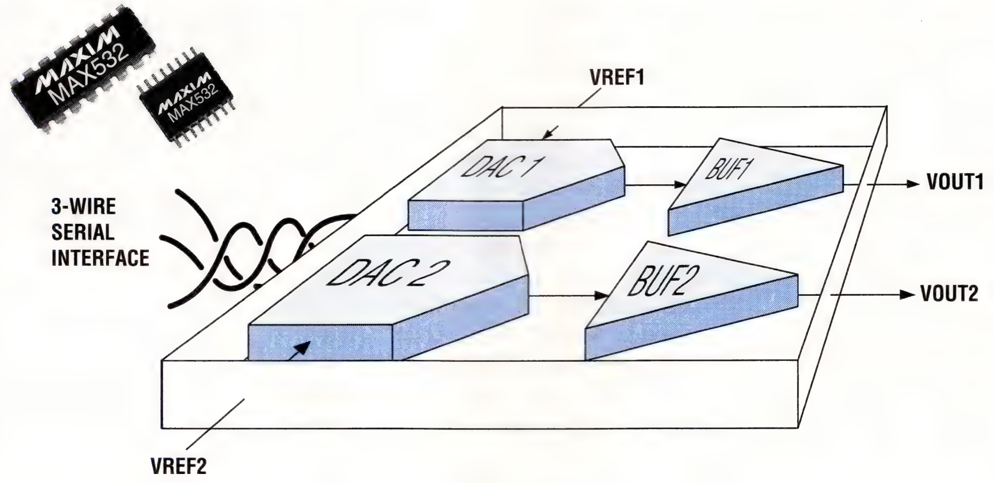
Two Voltage-Output 12-Bit DACs in 16-Pin DIP/SO – $8.45†



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CD-ROM CONTROLLER CONNECTS TO IDE INTERFACE

The OTI-011 is compatible with the IDE interface. The chip supports the newly adopted AT Attachment Packet Interface (ATAPI)—a subset of the IDE specification. The OTI-011 succeeds its ISA bus counterpart, the OTI-012.

Using the company's ATAPI drivers, the controller IC's plug-and-play architecture allows the PC to configure itself by identifying a IDE CD-ROM drive in the system upon power-up. In addition to the drivers, the optional bundled firmware has the ability to control some of the drive's internal functions.

The controller chip supplies an interface to the IDE bus without any data buffers or decoding logic. It supports 8- and 16-bit I/O data reads. The burst transfer rate is 8 Mbytes/s to the host. As a result, quadruple-speed drives can be employed.

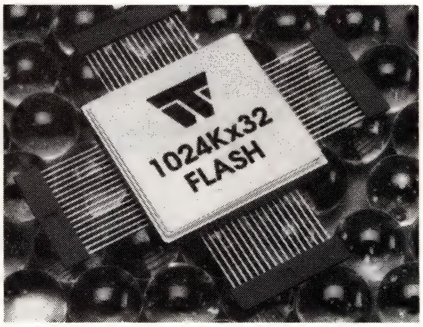
Housed in a 100-pin plastic quad flat pack, the OTI-011 is available now for $8.95 in lots of 10,000.

***Oak Technology Inc.**, 139 Kifer Ct., Sunnyvale, CA 94086; (408) 737-0888.* **CIRCLE 630**

■ *RICHARD NASS*

SURFACE-MOUNT MODULES HAVE 32-MBITS OF FLASH

Offering one of the densest formats for holding flash memory, the WF-1024Kx32 is a 68-lead ceramic quad flat package measuring just 1.385-in. (35-mm) on a side, and just 0.215-in. (5.5-mm) thick, yet packing up to 32 Mbits of flash storage. A thinner package, measuring just 0.14-in. (3.55-mm) high, is now in development. Organized as 1-Mword by 32-bits, the flash memory array in the module offers 100,000 erase/program cycles and can be had with access times of 100 or 150 ns. Programming requires a 12-V supply, but read-only operations just require 5-V. On standby, the array draws just 4 mA from the 5-V supply and when reading data, at full speed, the module's current drain increases to about 150 mA. The 32-Mbit modules can also be ordered with 8- or 16-bit interfaces. All are available for operation over the industrial (-40 to +85 °C) or full military (-55 to +125 °C) temperature ranges.



Screening to military standards is available to meet the requirements of MIL-H-38534 and MIL-STD-883. As a further option, the module can also be had in a 66-lead PGA package that also measures 35-mm on a side. Delivery is from stock to eight weeks. Price for the 68-lead CQFP version with the full military temperature range is $950 each in lots of 100.

***White Technology Inc.**, 4246 E. Wood St., Phoenix, AZ 85040; Jack Bogdanski, (602) 437-1520.* **CIRCLE 631**

■ *DAVE BURSKY*

TRIPLE DUAL-PORT BUFFER FORMATS COLOR PIXELS THUS REDUCING COLOR-SUBSYSTEM CLUTTER

Reducing the clutter in color subsystems by combining many storage functions typically required to handle true-color imaging, the color pixel formatter (CPF) also greatly improves system bus utilization efficiency. Developed by Galileo Technology, the GT-24001 contains three bidirectional dual-ported line buffers, each 32 bits wide, and each able to store 1104 words.

Such a 32-bit-wide depth is needed to handle color scanners that have resolutions of up to 400 dots/in. with a typical page length of 11 in. In addition to applications such as in color scanners, the GT-24001 chip can find homes in color printers, digital copiers, other image-processing systems. It can also find uses in applications that have nothing to do with imaging.

The GT-24001 was developed to perform three tasks. The first task is to reduce system costs and thus save the system manufacturer money. The second task is to increase system performance by reducing internal bus data-transfer overheads. And the third task is to reduce printed-circuit-board space.

The device's triple 1104-word buffers allow the chip to operate in either of two modes, a print mode or a scan mode. In the print mode, the chip performs format conversions from 32-bit planar color to 24-bit RGB color, or allows 24-bit RGB color to go straight through, or perform a 32-bit planar operation to 3-bit bi-level conversion. In the scan mode, 24-bit RGB color is converted to 32-bit planar color or 32-bit packed RGB color, or 3-bit bi-level data is converted to a 32-bit planar format.

In the planar mode, color information for all pixels is stored in the frame buffer in three different address spaces, one each for red, green and blue color signal, with each address containing 4 bytes of one color. In the RGB mode, color information for each pixel is stored in a single address, occupying 24 bits.

In the packed RGB mode, color information is packed as in the RGB mode, but in this case, it's in a 32-bit format, which includes data wrap-around. By using the planar mode in a frame buffer, designers can potentially reduce dynamic-RAM requirements by about 33%, in turn substantially reducing the cost for system DRAM.

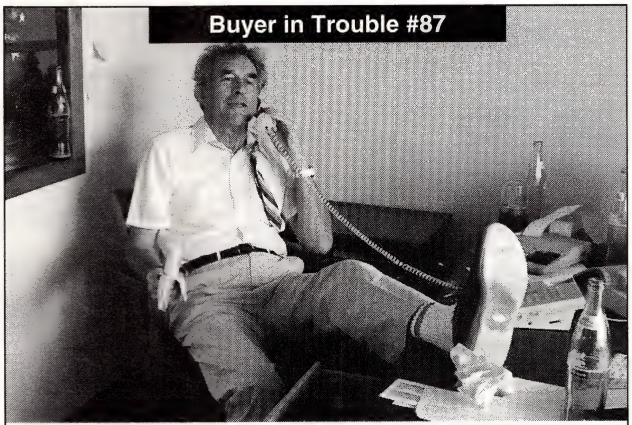
In addition to the triple buffers, the GT-24001 includes programmable video color for page margins, vertical and horizontal margin counters, as well as counters for the number of lines per page and the number of pixels in a line. Various modes can be configured on the chip. The configuration can be performed through a simple serial-peripheral interface (SPI). The SPI interface is compatible with the popular SPI interface that's included on many Motorola Semiconductor microcontrollers.

The multiple data ports on the chip—which include a 32-bit host-computer interface and three 8-bit-wide data ports—can be clocked at system bus rates at a frequency of up to 33 MHz. The remaining signal pins on the chip provide control interfaces. These interfaces are targeted for use with a video or print engine, as well as for a frame buffer.

Housed in a 128-lead PQFP, the GT-24001 CPF is the first in a family of chips to support color as well as gray-scale imaging systems. In quantities of 5000 units, the GT-24001 CPF is priced at $89.75 each. Samples of the GT-24001 CPF are immediately available.

Galileo Technology Inc., *1735 N. First St., Ste. 308, San Jose, CA ~~95112;~~ Manuel Alba, (408) 451-1400.* **CIRCLE 633**

■ *DAVE BURSKY*



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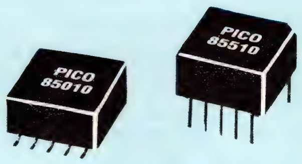

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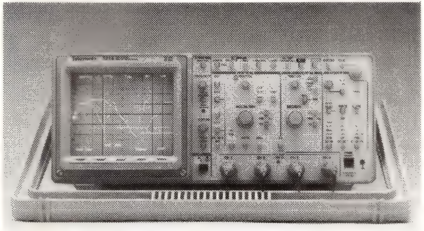
HYBRID SCOPE FEATURES DEEP WAVEFORM MEMORY

The Model 2216 hybrid analog-digital oscilloscope combines intuitive analog operation with a number of advanced digital storage capabilities, including full programmability. The four-channel, 60-MHz scope features 16 kpoints per channel of acquisition memory. A 128-kpoint per channel memory is optional. Features include 15 automated measurements, a hard-copy strip-chart mode, limit testing, and a custom-units capability. The Centronics-compatible parallel port permits downloading of waveforms and measurements. Users can store front-panel setups and up to 16 waveforms. The single-sweep roll mode, combined with a 0-to-100% selectable pretrigger on part of the acquired waveform, helps in analyzing slow-signal phenomena. The 2216 costs $3995. The 128-kpoint memory option is $1295. JN



Tektronix Inc., Test and Measurement Group., P. O. Box 1520, Pittsfield, MA 01202; (800) 426-2200. **CIRCLE 632**

8-CHANNEL ANTI-ALIAS FILTER BOARD IS RUGGED

A rugged RS-232-programmable anti-aliasing filter is well suited for use in front of any analog-to-digital converter in numerous industrial data-acquisition applications. The AAF-HE8P is an eight-channel board with a software-selectable cutoff-frequency range of 1 Hz to 50 kHz. The board has dc accuracy, 0.5° phase matching between channels, and a five-pole Butterworth filter with a maximally flat passband and low phase lag. Operational temperature is –40 to +105°. The board comes with menu-driven interface software for IBM PC compatibles. The software programs the selected cutoff frequency and verifies the setting. Custom applications software can also be used to control the interface. The AAF-HE8P costs $3950 and is available immediately. Volume discounts are available. JN

Alligator Technologies, 2900 Bristol St., Suite E-101, Costa Mesa, CA 92626-7906; (714) 850-9984. **CIRCLE 634**

CONTROLLER SENDS GPIB DATA AT 7.5 MBYTES/S

Equipping an EISA-bus PC with the EISA-GPIB turns the computer into a high-performance IEEE-488.2 (GPIB) controller. The EISA-GPIB performs the basic Talker, Listener, and Controller functions required by the IEEE-488 standard. The company's TNT4882C controller chip and HS488 protocol give the board data transfer rates greater than 7.5 Mbytes/s for both read and write operations. The board's hardware base address, interrupt, and DMA settings are software-configurable using the configuration utility included with EISA-bus computers. Included with the board is the NI-488.2 driver software for DOS and Windows. The software offers more than 50 GPIB-related routines and functions. The EISA-GPIB costs $595. JN

National Instruments Corp., 6504 Bridge Point Pkwy., Austin, TX 78730-5039; (800) 433-3488 or (512) 794-0100. **CIRCLE 635**

FUNCTION GENERATOR OFFERS HIGH OUTPUT

The PM 5138A function generator has an extended output range of up to 40 V pk-pk and a selectable output impedance of 50 or 600 Ω. The generator delivers seven standard waveforms: sine, square, triangle, positive and negative pulses, and ramp functions. Frequency bandwidth is 0.1 mHz to 10 MHz, with variable symmetry (duty cycle) of the generated signals. Modulation capabilities include am, fm, psk, burst, gating, and linear or logarithmic sweep. The unit also offers arbitrary waveform capability, with waveforms downloaded from a PC or digital oscilloscope over the optional IEEE-488 or RS-232 interfaces. The PM 5138A costs $3700. The arbitrary waveform capability with IEEE-488 or RS-232 interface options cost $4150. JN

Fluke Corp., P.O. Box 9090, Everett, WA 98206; (800) 443-5853. **CIRCLE 636**

CARD CREATES SPECTRUM PLOT FROM A-D INPUTS

The DI-280 Spectrum Grabber features a 16-MIPS digital signal processor that develops a 1-kpoint FFT in 15 ms. The half-slot, 16-bit, ISA-style card works with virtually any analog-to-digital or digital-to-analog card that supports DMA transfers. Users can program the card to eavesdrop on an 8- or 16-bit DMA channel that is inputting or outputting data. The card then generates a continuous FFT from the DMA data completely in the background and makes the FFT available to any program. Included is software that supplies an on-screen power-spectrum plot or a color, scrolling spectrogram in real time. Also, a 14-function dynamic link library supports Windows-based program development, and other libraries help with DOS—based programming. The DI-280 Spectrum Grabber costs $395, delivery is from stock. JN

Dataq Instruments Inc., 150 Springside Dr., Suite B220, Akron, OH 44333; (216) 668-1444.
CIRCLE 637

CARDS OFFER 3-POLE OR SOLID-STATE SWITCHING

Two multiplexer cards for the 7001 (two-slot) and 7002 (10-slot) switch systems have built-in memory devices that automatically configure the system for the number of channels, switch type, and switch setting time. The mainframes' analog backplanes make all intercard connections, eliminating card-to-card wiring in most applications. The 7015 is a 40-channel solid-state multiplexer that scans up to 400 channels or measurements per second. The card is configured as four independent banks of 1-by-10 two-pole switches. The 7018 28-channel three-pole multiplexer is for applications needing a three-wire switch configuration. The card features a Form A (single-throw, normally open) contact arrangement. Both cards handle signals up to 175 V peak. The 7015 costs $1595, and the 7018 goes for $1095. Both are available from stock. JN

Keithley Instruments Inc., 28775 Aurora Rd., Cleveland, OH 44139; (800) 552-1115 or (216) 248-0400. **CIRCLE 638**

PLD TEST SOFTWARE GETS HIGHER FAULT COVERAGE

Version 3.0 of the FS-ATG automatic test generation software creates test vectors for all PLDs, including high-density FPGAs and EPLDs from Altera, Xilinx, Actel, Advanced Micro Devices, and Lattice. The new 32-bit package has improved fault coverage and significantly faster run times than its 16-bit predecessor. It also covers more PLDs. The software is a DOS application for IBM PC compatibles, and also supports SCO Unix. Users specify fault coverage, run times, and the information to be included in testability reports. FS-ATG Version 3.0 costs $1900, with one PLD library. Additional libraries range from $1900 to $8900. Translators for in-circuit test systems are from $1900 to $3000. A translator for Viewlogic PLD design software costs $900. JN

Flynn Systems Corp., 7-1/2 Harris Rd., Nashua, NH 03062; (603) 891-1111. **CIRCLE 639**

SMALL DATA-ACQUISITION BOX FITS NOTEBOOK PCS

The DAQPad-1200 is a compact external data-acquisition peripheral compatible with any PC with a parallel printer port. Its 5.75-by-8.375-by-1.5-in. size and 1.7-lb. weight make the DAQPad-1200 ideal for applications using notebook PCs. The unit has a 12-bit analog-to-digital converter with a 100-ksample/s digitizing rate. It features eight single-ended or four differential channels; programmable gains of 1, 2, 5, 10, 20, 50, or 100; and a 2-ksample FIFO buffer. Also included are two analog outputs, 24 TTL-compatible I/O lines, and three 16-bit counter-timer channels. Two parallel ports allows users to connect the box to both a PC and a printer. The DAQPad-1200 with an ac adapter costs $995. A battery pack and charger cost $295. JN

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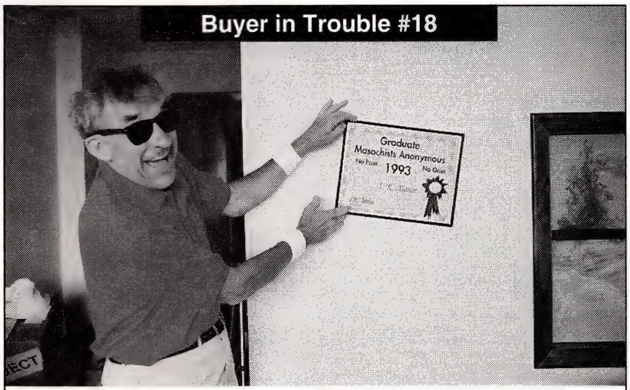

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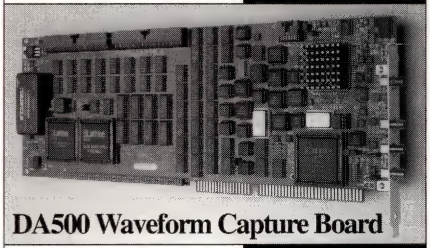

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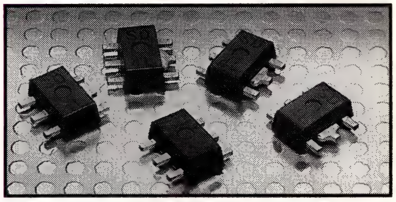

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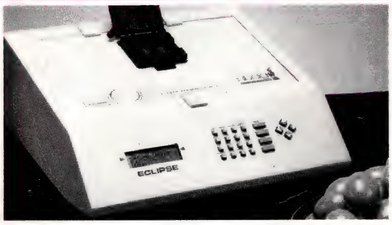

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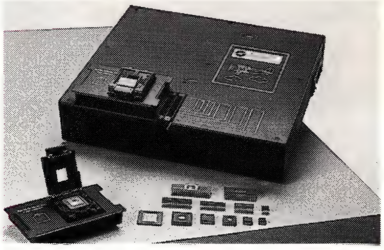

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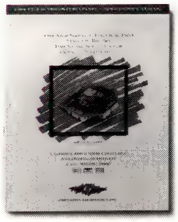

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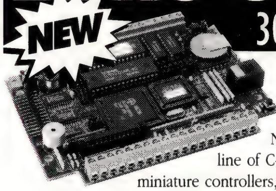

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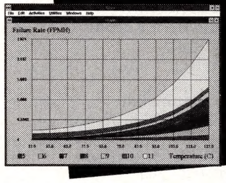

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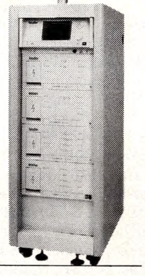

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INDEX OF ADVERTISERS

ADVERTISER	READER SERVICE	PAGE NUMBER
ACCEL TECHNOLOGIES	400	158
ADVANCED MICRO DEVICES	157	2-3
ADVIN SYSTEMS	401	158
ALLIED ELECTRONICS	168	95
AMPLIFIER RESEARCH	80	135
ANALOG DEVICES	82	83
ANALOG DEVICES	83	12-13
ANALOG DEVICES	81	57
ANCOT CORPORATION	84	10
APEX	85,86	1
ARIES ELECTRONICS	167	111
ASTEC AMERICA	158	108*
AT&T	171	39*
BASF	87	9**
BUD INDUSTRIES INC.	88	137*
BURR-BROWN	89,90	31
CLASSIFIED	---	159
COMPASS DESIGN	91	75
CONVERSION DEVICES INC.	92	140
COOPER & CHYAN TECH.	93	121
CTS CORPORATION	169	139
CYBERNETIC MICROSYSTEMS	95	16
CYPRESS SEMICONDUCTOR	---	COV4
DALLAS SEMICONDUCTOR	96	51
DATEL INC.	170	115
DIGI-KEY	97	9*
DIVERSIFIED TECHNOLOGY	98	52-53
DORMEYER INDUSTRIES	99	136*
EMULATION TECHNOLOGY	403	158
EMULATION TECHNOLOGY	402	158*
HYUNDAI	178	86-87*
HYUNDAI ELECTRONICS	105	36-37**
IBM MICROELECTRONICS	172	62-63
INNOVATIVE SOFTWARE	404	159
INTEGRATED CIRCUIT SYS.	106	36-37*
INTEGRATED DEVICE TECH.	---	104
INTEL CORPORATION	107,108	22-23
INTERNATIONAL POWER DEV.	109	128A-D
INTERNATIONAL RECTIFIER	110	26
J.W. MILLER	111	152*
KEYSTONE CARBON COMPANY	112	20
LAMBDA	113	96A-D*
LAMBDA QUALIDYNE INC.	114	71*
LINEAR TECHNOLOGY	115	73
MAXIM	154	149
MAXIM	155	151
MAXIM	156	153
MELCHER INC.	177	145*
MENTOR GRAPHICS	116	76
MF ELECTRONICS	151	11
MICREL SEMICONDUCTOR	176	61
MICRO LINEAR CORPORATION	174	138
MICRO NETWORKS	117	8
MINI-CIRCUITS	122	93
MINI-CIRCUITS	121	17
MINI-CIRCUITS	120	4
MINI-CIRCUITS	119	COV3
MINI-CIRCUITS	118	28-29
MISSION RESEARCH	---	10
MITSUBISHI ELECTRONICS	173	18-19*
MOTOROLA	160	67
MOTOROLA	159	49
MURATA ELECTRONICS	123	46-47
NATIONAL INSTRUMENTS	124	21
NATIONAL SEMICONDUCTOR	---	40-41
NATIONAL SEMICONDUCTOR	---	65
NEC	126	90
NEC	125	6
NJR	164	103
NOISE LABORATORY	405	159
ORCAD	127	COV2
PICO ELECTRONICS	165	156
PICO ELECTRONICS	165	150
POWER-ONE	128	98
PREM MAGNETICS	130	157
PREM MAGNETICS	129	155
QUALITY SEMICONDUCTOR	131	89
RAMTRON CORPORATION	133	34
RAYTHEON	150	54
ROHDE & SCHWARZ	134	59**
SAMTEC INC.	135	117
SEIKO INSTRUMENTS	409	158
SHARP MICROELECTRONICS	136	32-33
SIEMENS	137	18-19**
SIGNATEC	408	158
SILICONIX	---	43-45
SONY SEMICONDUCTOR	139	107*
SONY SEMICONDUCTOR	138	107**
SPECTRUM SOFTWARE	163	101
STAG MICROSYSTEMS	406	158
STANFORD RESEARCH	140	88
TADIRAN ELECTRONIC IND.	175	133
TEKTRONIX INC.	141	59*
TEXAS INSTRUMENTS	144	24-25
TEXAS INSTRUMENTS	142	113
TEXAS INSTRUMENTS	143	80-81
THOMSON-CSF	153	136*
THORDARSON-MEISSNER	145	154**
TOSHIBA	146,147	68-69*
TOTAL POWER	166	134
TRANSERA	161	102
VICOR	148	79
WALL INDUSTRIES INC.	149	134
Z-WORLD ENGINEERING	407	158

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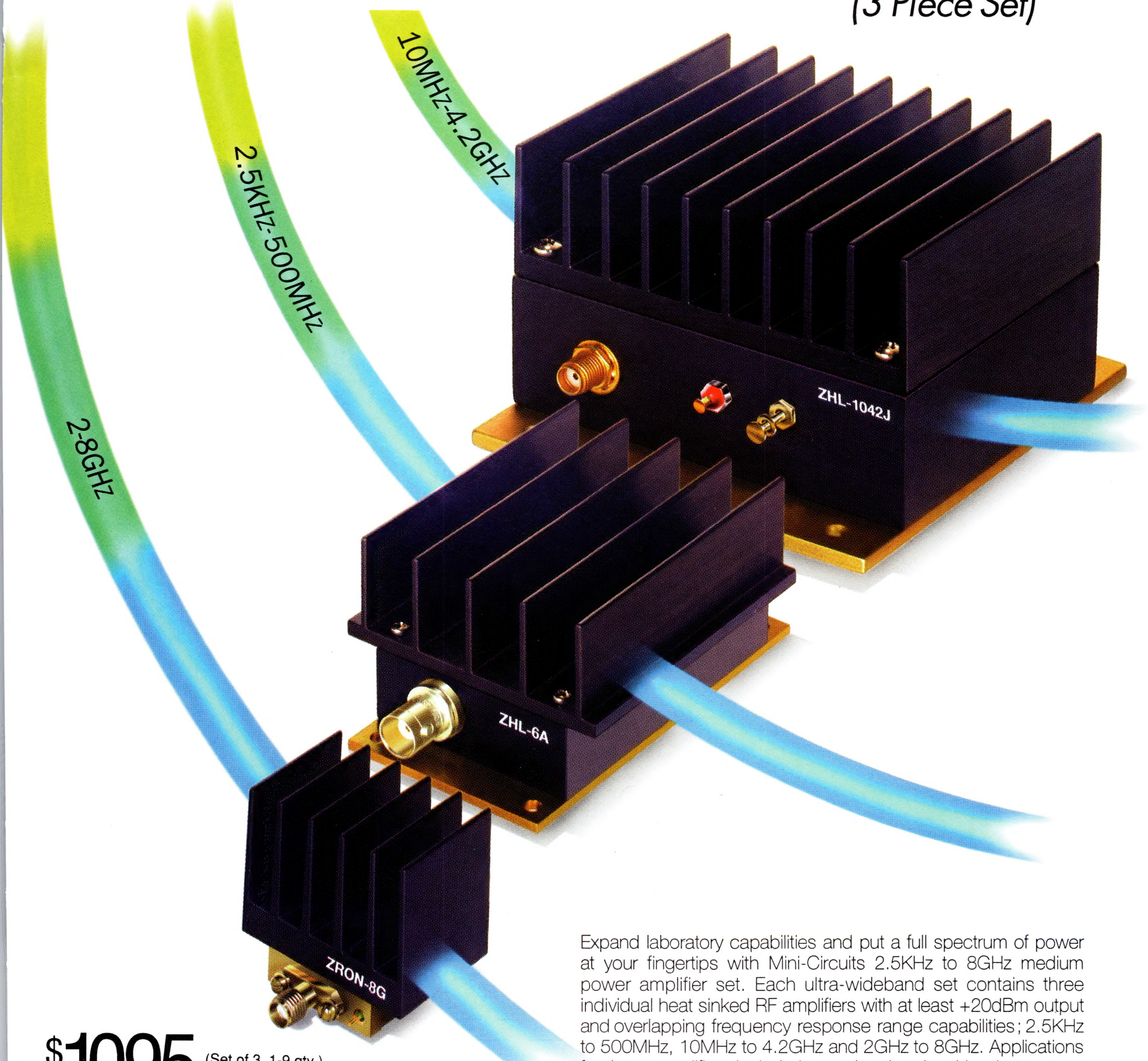

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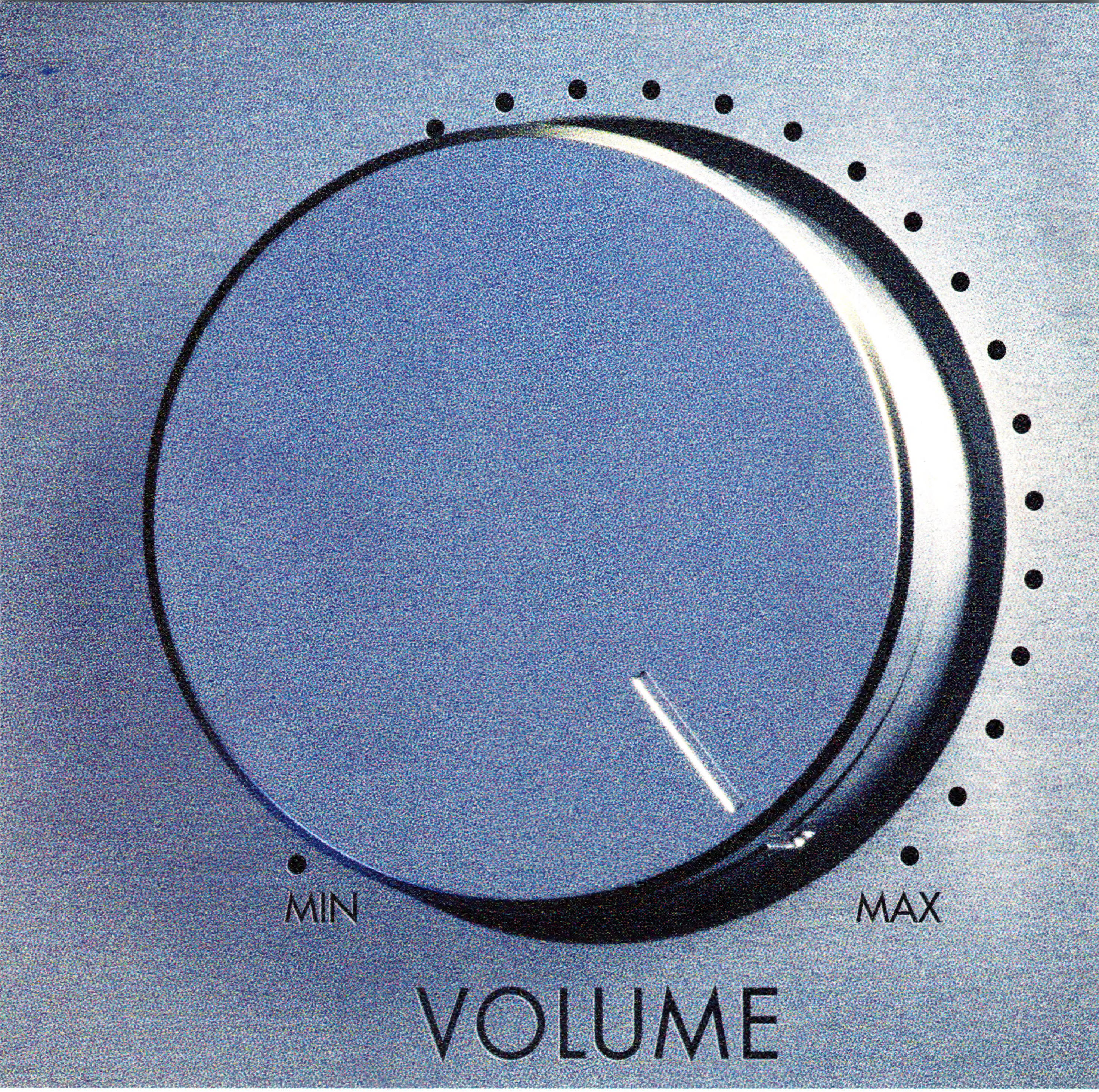

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